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Old MSS on Electricity

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M. Low

Electricity

A Brief History of Electricity.

Though it is certain, ever since the creation of the world, the electric fluid had all the operations it has at present, yet the discovery of its action, and even of its existence, is (comparatively speaking) of a very late date. Thales the Milesian, who lived 600 years before Christ, was the first who observed the electrical properties of amber. Of these, indeed, he knew no more than that this substance would attract light bodies when it was rubbed. For 300 years after his time, we hear nothing further concerning this subject. Theophrastus then tells us, that the

Sturcuriam (now called the Tourmalin) has the property of attracting light bodies, as well as amber. From this time there is a charm in the history of electricity for 1900 years. It was in the beginning of the 17th century that the subject of electricity became a distinct science; and the foundation was laid of those discoveries (which have since taken place) by D^r William Gilbert, an English physician, whom may justly be called the Father of Electricians. In the year 1600 he wrote a book, De Magnete which contains a variety of electrical experiments. All these, however, considered only the attractive property of certain substances, which, from their agreement in this respect with amber, were called electric.

Dr Gilbert's merit consists of his having been at great pains to find out a number of such substances, and thus considerably enlarge the number of electrics.

Till the year 1670, it does not appear that any farther discoveries were made, except some trifling additions to the number of electrics.

About this time W Boyle, ~~improved~~
~~farther. He made use of a sulphur globe~~
applied himself to the study of electricity: he enlarged the catalogue of electrics, & found that their electric properties were increased by warming & wiping them before they were rubbed.

Otto Guericke, however, who was contemporary with W Boyle, improved the science much farther. He made use of a sulphur globe whirled on an axis, much like our present

glass globes; by which means he excited a greater power of electricity than any of his predecessors, & tried all their experiments to much more advantage. He discovered the electric repulsion; & not only saw the electric light more clearly than Mr Boyle, but heard the hissing sound with which it is emitted. He also made another remarkable discovery; but which has since been very generally overlooked; viz. that a feather, when repelled by an excited electric, always keeps the same face towards the body which repels it, as the moon does to the earth.

The next discovery of any moment was made by Sir Isaac Newton; who observed that the electric attraction & repulsion penetrated through glass. In the year 1709 a treatise

was written on electricity by M Hawksbee; who not only far excelled all his predecessors and contemporaries, but also made some discoveries which well deserve the attention of the most expert electricians at this day. He was the first that applied a glass globe to the machine; & he remarked various appearances of the electric light & the noise that accompanied it, together with a variety of phenomena relating to electric attraction & repulsion.

After his death, not only the use of glass globes, but even the study of electricity itself, seems to have been pretty generally laid aside for some time. The reason of this was, that the recent discoveries of Sir Isaac Newton engrossed the attention of philosophers to such a degree, that they had no leisure for any other pursuits. However after

The death of that great man, electricity began to revive, and in 1729 a capital discovery was made by Mr Stephen Grey, (who by his curious observations) found out the difference between electrics & conductors; who, with the assistance of Mr Wheeler, contributed much to the advancement of electricity. Soon after, Mr Du Fay accidentally discovered the difference between positive & negative electricity, by observing that a piece of leaf gold repelled by an excited glass tube, was again eagerly attracted to it, after it had touched some body not an electric: the same was also the case with resin, sealing wax, sulphur, & a number of other substances. It may be observed, that although the science had, through the indefatigable attention of so many ingenious persons,

& by the discoveries that were daily produced,
excited ~~by~~ the curiosity of philosophers, & engaged
their attention: yet as the causes of every
thing, whether small or great, are seldom much
attended to if their effects are not particularly
striking & singular, so electricity had till the
year 1746 been studied by none but philosophers
until that capital discovery of the vast ac-
cumulation of its power, in what is called the
Leyden Phial, was accidentally ~~discovered~~
made by W. Muschenbroek in the year
1746: at which time the study of electricity
became so general, and gave more surprise
even to philosophers, than any other science
whatever. From the time of this discovery
electricity became the general subject of con-
versation & great numbers of people got their

liveliness, by going about & shewing its cu-
rious phenomena. It ^{was} ~~is~~ also applied medi-
cally, & several persons have found great
benefit by it, particularly a paralytic per-
son cured at Geneva; another of a violent pain
in his head; also a woman of a disorder in
her eyes at Bologna; so that ^{from} this time we
may date the introduction of electricity into
the medical art. It is impossible to enu-
merate all the happy effects which have been
performed in curing various disorders in-
cident to the human body by electrical
applications.

The science of electricity has since the a-
bove period, been greatly improved by the
indefatigable industry of the celebrated philo-
sophers Dr. Franklin & Dr. Priestly;

but it would be endless to enumerate all the improvements that have been made by a great number of other gentlemen, who have each added something towards its advancement, but whoever would make himself acquainted concerning those advances should read over the elaborate history of electricity compiled by the learned Dr Priestly: a work that will inform him of whatever has been done relative to the subject till its publication.

Of the Electric Fluid

The earth & all the bodies we are acquainted with, are supposed to contain a certain quantity of an exceeding elastic & subtle fluid, which philosophers have agreed to term electric. This certain quality belonging to all bodies, may be called their natural share; & so long as each body contains neither more nor less than this quantity, it seems to be wholly dormant, & produces no sensible effect; but the moment the equilibrium is disturbed, & any body becomes possessed of more or less than its natural quantity, very remarkable effects arise from it.

The body is said to be electrified, and is capable of exhibiting ~~the~~ appearances which are ascribed to the power of electricity.

This equilibrium could never be disturbed, or, if it was disturbed, would be immediately restored, & therefore be insensible, but that some bodies do not admit the passage of this electric fluid through their pores, or along their surfaces, though others do. By this means whenever any body has acquired an additional quantity of electric matter, & is everywhere surrounded with bodies ^{through} which it cannot pass, it must remain overloaded; or, if it has lost part of what naturally belonged to it, it must remain exhausted; because the surrounding bodies prevent any of the fluid from going to it, or coming out of it, & the body is then said to be insulated. Those bodies through which the electric fluid

can pass are called conductors; & those through which it cannot pass, are called nonconductors of electricity; & into these two kinds all bodies are classed by electricians.

The best conductors of electricity, ~~are~~ ^{or} those which admit the fluid to pass through them with the greatest ease, are metals of all kinds. And the most perfect of the nonconducting class of bodies, are glass, resin, sealing wax, sulphur, beeswax, & baked wood, among solids, & oils & air among fluids.

But all substances become conductors when they are made very hot. They are also called electrics, & the conducting substances are called non electrics.

The method of disturbing the equilibrium of the electric fluid in bodies, is chiefly friction.

or a slight rubbing of them one against another. In this case, the electric fluid will in general leave that substance which has the rougher surface, & pass upon the other which is smoother; or it will leave that substance which is the less perfect electric, & pass upon the other which is the more perfect electric of the two. Thus if I take a
smooth glass tube (such as is Plate 3
fig. 1.
represented) & draw it through my hand, the effect of that friction is that the electric matter leaves my hand, & passes upon the glass, where it will remain as an addition to its natural quantity. For as neither the glass, nor the air that surrounds it, are conductors of electricity, this redundancy of the electric matter cannot

possibly get away; but if my finger, a piece of metal, or any conducting substance be presented to any part of the glass thus overloaded with electric fluid, it will pass immediately from that part in to them, & if they be presented to every part of the tube successively, the whole of this redundant electricity will be discharged, & every thing will become just as it was before the operation. The glass in this case is said to be excited, because the friction seems to excite, or call upon the electric power which it had before, but which lay dormant in it.

In like manner, when the globe is whirled in the electrical machine, the friction of the glass against the rubber make the electric fluid which was in the rubber pass on the glass, from whence it is con

veyed to the prime conductor, the points of which are presented to every part of the globe in succession: & as the friction is continued, there will, by this means, be a constant supply of the electric matter to the prime conductor, though other bodies be presented to it, & keep discharging it all the while in visible sparks. The hand in the former of these cases, & the rubber in the latter, which had parted ^{with} ~~from~~ their share of the electric fluid to the glass, against which they were rubbed receive an immediate supply from the conducting substances in contact with them: & these are again supplied by the general mass of the fluid that is lodged in the earth.

On the contrary if I draw through my hand a stick of sealing wax, a piece of sulphur, or a tube of rough glass, the effect of the friction is,

that a quantity of electric matter naturally belonging to the sulphur &c. passes from it to my hand, & the sulphur being surrounded by the air, which is a non-conductor, remains exhausted, & is ready to take sparks of electric fire, from any bodies that are presented to it. But it is impossible to distinguish by the eye which way the electric matter passes, its velocity is so great. The sulphur in this case, though deprived of its share of electricity, is said to be excited as well as the glass which was overloaded with it. Because, though the state they are in be the reverse of one another the effects produced by them are, in many respects similar. The appearances which lead us to distinguish them will be mentioned hereafter.

Of Electrical Attraction & Repulsion.

The great laws of the electric fluid, those on which all the phenomena of electricity depends are that it is in a much higher degree elastic, & repulsive of itself; that 2 bodies having both of them either more or less than their natural share, repel one another; but that if one of them have more, & the other less than its share, they will attract one another.

Thus: if I hang a bundle of hairs or feathers upon the prime conductor, the moment I electrify them, by turning the wheel of the machine, they begin to fly from one another; so that some of them will stand quite erect. in a beautiful manner; & they cannot be made to collapse & be brought in contact with one another till I discharge the conductor, by taking a spark from it with a piece of metal, or some other

conducting substance. A large plummy feather will grow beautifully turgid when it is electrified, expanding its fibres in all directions, & they collapse when the electricity is taken off.

If I hold in my hand a bundle of threads, hairs, or feathers, & present them to the electrified conductor, the electric fluid with which the conductor is over loaded, repels the electric fluid from those parts of the threads &c. which are next to it, into the more distant parts of those bodies, or into my hand, & so into the ground; the consequence of which is, that the threads having less than their natural share, do strongly repel & avoid one another, & at the same time are strongly attracted by the conductor, which is in an opposite state, if the conductor had been deprived of its natural share of electricity. The bodies presented to it would have had more.

than their natural share, so that still
the same appearance of mutual repulsion,
& of attraction by the conductors, would have
taken place, & universally all bodies that
are brought within the influence of electrified
bodies, whether they are so by having more or
less than their natural share of the electric
fluid, become possessed of contrary ~~share~~ of
electricity. For the same reason excited elec-
trics of every kind attract all light bodies
which are brought within the sphere of their
influence.

Electrical ^{attraction & repulsion} are exhibited in a pleasing man-
ner, by means of a glass tube & a feather.
When the tube is excited, by being drawn through
the hand, or a rubber, the feather, when brought
near it, will be attracted & jump to the tube
then taking some time to get fully saturated.

with electric matter (because being a bad conductor it can receive it but very slowly) it will suddenly jump from it & fly towards the next conductor, upon which it may discharge the redundant electricity it has acquired. If no other body happen to be in the way, it will tend towards the ground, but if the electrified tube be held under it, it will still be repelled & driven into the middle of the room where it may be kept suspended, or driven about in all directions, almost as long as a person pleases, if the air be dry.

Other beautiful effects of electrical attraction & repulsion are ^{shown} at the prime conductor belonging to the machine. Suspend a plate of metal from the conductor which is supported by a glass pillar, & must be supposed to be supplied with electricity from the globe; & underneath it, at the distance of about 3 or 4 inches.

put another plate of the same size, upon
the lower of these plates lay a feather, or a small
slip of light paper. & as soon as the wheel begins
to turn, the feather or the paper will be attracted
& jump to the upper plate F, from
which it will be immediately re-
pelled, & fly to discharge it self upon the lower
plate P. which is supported on the pedestal H G;
after which it will be ready to be attracted & repelled
again, thus will the feather or paper fly from the one
plate to the other, alternately, & with inconceivable
rapidity, if the electrification be pretty vigorous. When
the pieces of paper are cut into the figures of men
or women, they exhibit a kind of dance, which
is extremely amusing.

This experiment will be more diverting, if it be ac-
companied with that of the electrical bells, which
depends on the same principle. { Fig. 5.

Four bells a, b, c, d. hang from brass rods, communi-
cated with the prime conductor. & another bell, e,
fixed on a brass pedestal A. reaching to the ground
& 4 small brass balls, suspended by silken threads,
hang between a, b, c, d. & the bell e. in the middle.
The consequence of this disposition is, that the out-
ermost bells which hang from the prime con-
ductor by brass chains, are electrified, & attract the
brass balls which hang by silk, & the attraction
being vigorous, they are made to strike the
bells with some force, & make them ring. Being
then loaded with electricity, they are immedi-
ately repelled from the outermost bells, & fly
to unload themselves, by striking upon the
middle bell, which is insulated by the
glass pillar B. upon the pedestal A. ^{from} The
which the electric matter passes to the floor, by means of
brass balls, which may now be called clappers
the brass pedestal A.
to the bells, are then ready to be attracted by the

outermost bells, as at first; & thus the ringing may be continued as long as it is agreeable. The amusement will be heightened, if the electrician now then touch the prime conductor with a brass rod, or with his finger, for then the dancing & ringing will cease, & will not be renewed, till the brass rod, or his finger be removed. If he conceals this application of his finger, or the rod, with a little art, the figures will seem to dance & the bells ring at the word of command.

Of the electric Spark.

When I present a piece of metal, or any other good conducting substance, to the overloaded prime conductor, the electric matter will pass with violence from the one to the other, an electric spark with the appearance of fire will be seen, darting between them, & a report which is usually compared to a snapping noise.

will be heard. If the piece of metal presented to the prime conductor be insulated, so that it cannot immediately lose what it receives it will only take part of the charge from the prime conductor (the whole of the redundant electricity being divided between them in proportion to their surfaces) & either of them will give a smaller spark to another body that is presented to them.

When any person { Fig: 7
stands upon the stool with
feet made of glass, or baked wood, & takes in his hand a chain fastened to the prime conductor: being then insulated, he may be considered as a part of the prime conductor & any part of his body will exhibit all the same appearances which the prime conductor itself

will do. This if the finger of any person be presented to him, a spark of fire will seem to issue from him, & both him & the person will feel a painful sensation like a picking & the same snapping noise will be heard.

Every part of his body will then attract light substances, & the bits of feathers, or the human figures cut in paper & laid on a plate, will perform the same dances that were mentioned before if the palm of his hand be extended over them. Also the hairs of his head, or of his wig, if they happen to be loose, will repel one another, & many of them will stand up right. As these electric sparks, which are attended with a sensation moderately painful will be excited whenever he is touched, or wherever he touches any other person, this experiment will

thereby furnish great diversion.

The electric spark has not only the appearance of fire but is capable of actually setting fire to various substances that are easily inflamed, but the inflammation is probably produced by the rapid motion into which the parts of the substances are thrown by the action of the electric matter upon them.

Thus if spirits of wine be held in a spoon & an electric spark be drawn from the spoon so as to pass through any part of the spirit, they will catch fire. Burn as if lighted by a candle. The spoon in which the spirits are contained may either be connected by the prime conductor, & the spark drawn through them by a person standing on the floor; or the spoon may be held by a person standing on the floor, the spark drawn through them by a brass rod.

either connected immediately with the
prime conductor, or held in the hand of a person
standing on the stool before mentioned. If a candle
be blown out, & an electric spark be immedi-
ately drawn through the smoke, it will often
be lighted again, but it requires a pretty strong
spark, & some degree of dexterity & experience in
the operator, to produce this effect with certainty.
It will be more amusing & the effects will be as
certain, if the spark be drawn through the
spirits by the end of a persons finger.

Not only are the senses of feeling, seeing, &
hearing, affected by electricity in the man-
ner before described, but it is even sensible
to the smell & taste. If a pointed glass rod be
electrified, either by being fastened to the prime
conductor, or held in the hand of a person electri-
fied, & another person standing on the floor,
present his nostrils within an inch or 2 of the

point, he will feel a strong & disagreeable
smell, like that of burning sulphur; if he
receive the electric effluvia issuing from the
point upon his tongue, he will perceive a
taste which is manifestly acid.

The machine represented, was such as the
Rev. Mr Timothy Priestly used, on account
of its simple construction, as not { Fig 2
being liable to be out of order soon

having no wheel or string, either to make
any noise or need alteration; it may be
fixed firm on a table, & taken off in a
moment; & the globe may be taken out with
the greatest ease, in order to be packed up.

When the inside of the globe is lined with
his composition, hereafter mentioned, it will
produce more fire than any other compo-
sition that I know of.

The spring S, that is represented in the plate is for those that care not for having the rubber insulated: but those that are inquisitive, may have them made with the rubber well insulated, by a glass pullon, that will { Fig. 1
hold the rubber to the back part { Plate 1
of the globe, as represented.

A is a piece of mahogany, 9 inches { Fig 2
square, & 1 inch & 1/2 thick, in which {
a pedestal B. is fixed: C is an iron axle, to
which is fixed a brass cap, & to which the
globe G. is firmly cemented, & runs in the brass
socket E, through the middle of the pedestal B.
Turned by the handle H.

R. is the rubber, which is made of a piece of
wood cut to the curve of the globe, to which is
fixed a leather covering, which being at a little

distance from the wood in the middle it will yield to the pressure of the globe the better. On this leather is another leather, which will take off by taking out a pin, on this the amalgam is rubbed, & being so easily taken off, is more readily brought into order than those which have only 1 leather, & that fixed to the rubber. To this outer most leather is fixed a piece of black silk, which reaches $\frac{1}{2}$ round the globe, & greatly increases the fire, so that it will give fire well, if the rubber scarce touch the globe. This machine will suit any kind of conductor, but I prefer paper globes covered with tin foil, they being in my opinion the most compact & retain the electric effluvia better than any other shape.

Of the Influence of points in Electricity

The more acutely pointed any bodies are, the more easily do they take or part with the electric matter. Thus if a needle, or sharp pointed wire, be fastened to the prime conductor it will retain but a small degree of electricity & consequently will give but a small spark when the finger or a piece of metal is presented to it. Also if the needle, or sharp pointed wire be held in the hand of a person standing on the floor, & presented to the prime conductor, it will likewise be found to contain but a small degree of electricity. In the former of these cases, while the needle was in contact with the prime conductor, the electric matter went off at the point, & was dispersed in the air or among the conducting particles, which are always floating in the com

mon atmosphere. In the latter case the needle being presented towards the conductor receives the electric matter from it at a considerable distance.

If these experiments be made in the dark a flame will be seen at the point of the needle, or wire, but the appearances of the fire will not be the same in both cases, but considerably different, so that it may be always perceived by the eye, whether, according to the common theory, the point be receiving or giving out the electric matter.

If the sharp pointed wire be giving out the electric matter the flame will be large; the parts of which it consists will be fewer. If the point be not very acute, a kind of snapping noise will be heard as the electric matter is issuing out of it into the air; whereas, if the pointed wire be receiving the electric mat

ter, the flame will be much smaller, more globular, the parts of which it consists will be more in number, & the noise that is made will be a kind of hissing. The flame issuing from a body is called a pencil, & when the rays come to a point they project more equally from the center, & it is then called a star.

The reason why pointed bodies transmit the electric fluid with so much ease, has not yet been thoroughly explained; but the effects of it are exceedingly remarkable. The capital use that has been made of this observation, has been to draw the electric matter from the clouds, & thereby to prove that lightning & electricity are the same thing. for if a long rod or pole with a sharp pointed wire at the end of it be supported by electric substances, the point projecting towards the clouds will draw the electric matter from them & become

sensibly charged with electricity, just as it would have been from being connected with the prime conductor of an electrical machine. It will attract light bodies, sparks of electric matter may be drawn from it & it will exhibit every appearance of common electricity; as on the other hand, we can produce all the known effects of lightning, by common electricity.

Several amusing experiments depend on property of pointed bodies, to transmit the electric fluid. If a plate of tin { Fig 6 be cut into the form of a star, & be supported on its center D. by a wire projecting from the prime conductor AB; as soon as the wheel of the machine is turned, this apparatus electrified, a flame will appear at the extremity of every angle of the star, which will be very

beautiful, if the star be made to turn
swiftly on its center, an entire circle of fire
will be seen in the dark. This experiment
will be very surprising to persons unacquaint-
ed with electricity, if the operator now then
privately touch the prime conductor, which
may easily be managed, as it is per-
formed in the dark, for by this means
he may command the appearance
or disappearance of the star, or circle of
fire at pleasure.

If 2 Sharp pointed wires be bent, with the
ends at right angles, in the same plane,
but pointing different ways, & be made to
turn upon a center D. the moment it is
electrified a flame will be seen at the
points a. b. c. d. but what is most surpri-
sing in the experiment is, that the wire
will at the same time, begin to turn

round in the direction opposite to that in which the points are turned, and if the electrification be continued, the motion will presently become very rapid.

If the figures of houses, bent in paper, & fastened upon the wires, be so contrived that the points shall be in their tails the experiment will be very beautiful; the houses will seem to pursue one another, though without a possibility of any one of them overtaking the rest, & this is called the electrical house race. It is possible to make several of these wires, each having a considerable number of points bent backwards, with houses &c. fastened to each of them & turning one above another. & then some of them may be contri-

ved to move faster than others. They may also be made to move different ways.

Promiscuous Experiments.

The reader in the course of this work must observe, in several of the experiments already described, the remarkable property that points have, both of throwing off & receiving silently the electric fluid; but hereafter I shall describe some curious experiments of this kind, by which the influence of points, in respect of electricity, may be better understood, & which may in a more particular manner demonstrate the utility of metallic conductors to houses or piles of building, or in order to preserve them from the damage often occasioned by a stroke of lightning; which is one of the greatest bene

fits mankind has received from the
science of electricity.

The Dancing Balls. Exp 1.

Fix a pointed wire on the prime conductor, with the point outwards then take a glass tumbler, grasp it with both your hands, & present its inside surface to the point of the wire on the prime conductor while the machine is in motion. The glass in this manner will soon become charged; for its inside surface acquires the electricity from the point. Its outside loses its natural quantity of electric fluid through the hands which serves as a creating. This done put a few pith balls on the table & cover them with this charged tumbler.

The balls will begin immediately
to leap up along the sides of the glass
as represented. I will continue
their motion for a considera- { Fig 9
ble time

In this experiment the pith balls
are attracted & repelled by the electric
fluid superinduced upon the inside sur-
face of the glass which they gradually
conduct to the table or other conducting
body upon which the glass is set at the
same time that the outside surface
of the glass acquires the electric fluid
from the contiguous air. This expe-
riment may be made more inter-
esting by having a glass cylinder 3 inches
long & the same in width. open at

both ends, with a brass plate fixed
on its top. put any number of balls you
please & electrify the brass cover, & the
balls will dance with a very rapid
motion, which will continue as long
as the operator turns the machine

To prove that Glass & other electrics
become conductors, when they are
made very hot. Exp 2.

In order to ascertain the conducting
quality of hot resinous substances,
oils, &c. Bend a glass tube { Fig 10.
in the form of an arch CE
FD. & tie a silk string GCD to it, which
serves to hold it by, when it is to be set
near the fire: fill the middle part of
this tube with resin, sealing wax, &c

Then introduce 2 wires, A.E. B.F. through
its ends, so that they may touch the
rosin, or penetrate it a little way.
This done let a person hold the tube
over a clear fire, so as to melt the rosin
within it, at the same time, by connecting
one of the wires A or B. with the outside
of a charged jar & touching the other with
the knob of the jar, endeavour to make
the discharge through the rosin & you will
observe that while the rosin is cold, no
shocks can be transmitted through
it, but it becomes a conductor, accor-
ding as it melts, & when totally mel-
ted, then the shocks will pass through
it very freely.

The Thunder House

Is an instrument representing the side of a house, either furnished with a metallic conductor, or not; { Expt 3 by which both the bad effects { Fig. 2 of lightning striking upon a house not properly secured, & the usefulness of metallic conductors may be clearly represented. A is a board about $\frac{3}{4}$ of an inch thick, & shaped like the gable end of a house. This board is fixed perpendicular upon the bottom board B, upon which the perpendicular glass pillar C D is also fixed in a hole about 8 inches distant from the basis of the board A. A small hole ILMK about $\frac{1}{4}$ of an inch deep, & nearly 1 inch wide, is made in the board A, & is filled

with a square piece of wood, nearly of the same dimensions. I mention nearly of the same dimensions, because it must go so easily into the hole, that it may drop off by the least shaking of the instrument. A wire LK is fastened diagonally to this square piece of wood. Another wire IH of the same thickness, having a brass ball H screwed on its pointed extremity, is fastened on the board. A: so also the wire MN, which is shaped in a ring at O. From the upper extremity of the glass pillar CD, a crooked wire proceeds, having a spring rock at E, through which a double knotted wire slips perpendicularly, the lower knot G of which falls just above the

Knob H. The glass pillar DC must not be made very fast into the bottom board; but it must be fixed so as it may be pretty easily moved round its own axis, by which means the brass ball G may be brought either nearer or farther from the ball H, without touching the part EFG.

Now, when the square piece of wood LM IK (which may represent the shutter of a window or the like) is fixed into the hole, so that the wire IK stands in the dotted representation IM, then the metallic communication from H to O is complete, & the instrument represents a house furnished with a proper metallic conductor; but if the square piece of wood LM

IK is fixed so that the wire IK stands in the direction I.K. as represented in the figure, then the metallic conductor HO, from the top of the house to its bottom, is interrupted at IM in which case the house is not properly secured.

Fix the piece of wood I.M.IK, so that its wire may be as represented in the figure in which case the metallic conductor HO is discontinued. Let the ball G be fixed at about 2 or 3 inch perpendicular distance from the ball H, then, by turning the glass pillar DC, remove the former ball from the latter; by a wire or chain, connect the wire EF with the wire Q of the jar P. Let another wire or chain, fastened

to the hook O, touch the outside
coating of the jar. Connect the wire
Q with the prime conductor, & charge
the jar; then, by turning the glass pil
lar DC, let the ball G come gradually
near the ball H, & when they are arrived
sufficiently near one another, you will
observe that the jar explodes. The piece
of wood LMK is pushed out of the
hole to a considerable distance from the
thunder house. Now the ball G, in this
experiment, represents an electrified
cloud, which when it is arrived suffi
ciently near the top of the house, & the
electricity strikes it; & as this house is not
secured with a proper conductor, explo
sion breaks part of it, i.e. knocks it
of the piece of wood IV.

Repeat the experiment with only this variation, viz. that this piece of wood *IM* is situated so that the wire *IK* may stand in the situation *IM*, in which case the conductor *HO* is not discontinued; & you will observe, that the explosion will have no effect upon the piece of wood *IM*. This remaining in the hole unmoved; which shows the usefulness of the metallic conductor.

Further unscrew the brass ball *H* from the wire *HI*, so that this may remain pointed & with this difference only in the apparatus, repeat both the above experiments; & you will find the piece of wood *IM* in neither case moved from its place, nor any explosion will be heard.

Of the Electrical Battery.

A number of coated jars connected together in such manner that their whole force may be united, & act like 1 jar, constitutes what is called an electrical battery. This battery is ~~the~~ most formidable & interesting part of an electrical apparatus; & by its use many wonderful effects are produced. { Fig 12

If a battery is required of no very great power, as containing 1 or 9 square feet of coated glass, I should recommend to make use of common pint or 1/2 pint phials, such as a pharmacist uses. They may be easily coated with tin foil on the outside & brass filivars on the inside; they occupy a small space, & on account of their thinness hold in very good charge. But

when a large battery is required, then these phials cannot be used, ^{for} they break very easily. For that purpose cylindrical glass jars, of about 15 inches high & 4 or 5 inches in diameter, are the most convenient.

When glass plates or jars having a sufficiently large opening, are to be coated, the best method is to coat them with tin foil on both sides, which may be fixed upon the glass with paste made of wheat flour; but in case the jars ^{not} have an aperture large enough to admit the tin foil, an instrument to adapt it to the surface of the glass, then brass filings, such as are sold by

the pin makers, may be advantageously
used; & they may be stuck with gum wa-
ter, beeswax, &c. Care must be taken that
the coatings do not come very near the
mouth of the jar, for that will cause the
jar to discharge itself. If the coating is
about 2 inches below the top, it will in
general do very well; but there are some
kinds of glass especially tinged glass,
that when coated & charged, have the
property of discharging themselves more
easily than others, even ^{when} the coating
is 5 or 6 inches below the edge. There is
another sort of glass like that of which
Florence flasks are made, which on
account of some unvitrified particles
in its substance, is not capable of
holding the least charge; and these

accounts therefore when ever a great number of jars are to be chosen for a large battery, it is advisable to try some of them first, so that their quality & power may be ascertained.

A battery composed of 12 jars coated in the inside & outside with tin foil, which altogether contain about 12 feet of coated glass. About the middle of each of these jars is a cork that sustains a wire, which at the top is fastened round, or soldered to the wire *F*, knotted at each end, which connects the inside coatings of 3 jars; & by 4 wires such as *FF*, the inside coatings of all the 12 jars may be connected together. Each of the wires *F* has a ring at one end, through which one of the

wire F passes & the other end has a brass
knob. If the whole force of the battery is
not required, 1, 2, or 3 rows of jars may
be used at pleasure; for as each of the
wires F' is moveable round the wire
 F , which passes through its ring, rests
upon the next wire F it may be easily
removed from that, & turned upon the con-
trary wire F ; & thus the communica-
tion between 1 row of jars & another
may be discontinued at pleasure.

The square box that contains these jars is
of wood, lined at the bottom with tin foil,
& has 2 handles on 2 opposite sides, by
which it may be easily removed. In
1 side of the box is a hole through which

an iron hook passes, which commu-
nicates with the metallic lining of the
box, & consequently with the outside coat-
ing of all the jars, to this hook is fastened
a wire, the other end of which is connect-
ed with the discharging rod.

The discharging rod consists of a glass
handle A, & 2 curved wires BB, which
move by a joint C, fixed to the brass cap
of the glass handle A, the wires BB
are pointed, & the points enter under ^{Fig 4}
the knots DD, to which they are moved.
I may be unneeded from them at plea-
sure. By this construction we have
the opportunity of using the ball or points
as occasion requires: & as the wires are

moveable by the joint C, they may be adapted to larger or smaller a pleasure. The battery represented in the plate is a small one in comparison to those now used, & much too weak for the purpose of some experiments. But I thought it sufficient to give an idea of its construction: When a large battery is to be constructed, I would recommend rather to make 2, 3, or more small ones as represented in the plate. than a single large battery, which is heavy, & on several accounts, inconvenient. The force of several small batteries may be easily united by a wire or chain: Thus they may be made to act in every respect like a large one.

The best construction of a battery is to have a wire from every jar connected with a ball at the top in form of a wire cage. The force of accumulated electricity, great as it appears by the experiments performed with a single coated jar, is very small when compared with that which is produced by a number of jars connected together. Lest the effects of a single jar are surprising, the prodigious force of a large battery is certainly astonishing. ^{So large} So that the metals, even the most purified platinum which resists the greatest efforts of chemist fire, are actually & almost instantaneously rendered red hot.

to see animals destroyed, & to hear the loud report of a large electric battery, are things that always produce a kind of terror in the mind of an attentive observer. Experiments of this kind should be conducted with great caution: & the operator ought to be attentive not only to the business in hand, but also to the persons who may happen to be near him, prohibiting their touching, or even coming too near any part of the apparatus: for if a mistake in performing other experiments may be disagreeable, those in the discharge of a large battery may be attended with even consequences.

When a battery is to be charged, instead of a large prime conductor, a small one is much more convenient; for in this case, the dissipation of the electricity is not so considerable. The quadrant electrometer, which shows the height of the charge in the battery, may be fixed either upon the prime conductor or upon the battery: in which case it should be fixed upon a rod proceeding from the axis of the jar: if the battery be very large, it should be elevated 2 or 3 feet above them.

The index of the electrometer in charging a large battery will seldom rise

so high as 90° because the machine cannot charge the battery so high in proportion as a single jar. Its limits is often about 60° or 70° more or less in proportion to the size of the battery & the force of the machine.

The Spider seemingly animated by Electricity

An electric jar, having a wire C D E, fastened on its outside, which is bended so as to have its knobs E as high as knob A. B is a spider (Experiments made of cork with a few short threads run through it to represent legs. This spider is fastened at the end of a silk thread, proceeding from the ceiling of the room.

or from any other support, so that the spider may hang midway between the 2 Knobs. A E when the jar is not charged. Let the place of the jar upon the Table be marked. Then charge the jar by bringing its knob A, in contact with the prime conductor, & replace it in its marked place. The spider will now begin to move from knob to knob, & continue this motion for a considerable time, sometimes for several hours.

The inside of the jar being charged, positively, the spider is attracted by the knob A, which communicates to it a small quantity of electricity. The spider then becoming possessed of the same electricity with the knob A, is repelled by it.

turns to the Knob E. when it discharges its electricity, & is then attracted by the Knob A, & so on. In this manner the jar is gradually discharged: when the discharge is nearly completed, the spider finishes its motion.

Exper 5 } The Spiral Tube. { Fig 18.
An instrument composed of 2 glass tubes C D, one within another, & closed with 2 knobbed caps. A & B. The innermost of these tubes has a spiral row of small round pieces of tin foil stuck upon its outside surface lying at about $\frac{1}{3}$ of an inch from each other. If this instrument be held by one of its extremities, & its other extremity be presented to the prime conductor, every spark that it receives from the

prime conductor, will cause small sparks to appear between all the round pieces of tinfoil stuck upon the innermost tube, which in the dark affords a pleasing spectacle, the instrument appearing encompassed by a spiral line of fire.

The small round pieces of tinfoil are sometimes stuck upon a flat { Fig 19.
piece of glass ABCD, so as to
represent curve lines, flowers letters &c.
They are illuminated after the same
manner as the spiral tube; i.e. by
holding the extremity C or B in the
hand, & presenting the other extrem-
ity to the prime conductor, when the
machine is in motion. They may also
be fixed in any other position, by connecting wires.

To show that the Electric Fluid pre-
fers a short passage through air
to a long one through good
Expos. D. conductors. (Fig 16.)

Bend a wire about 10 ft. long, at the
ends of which fix a piece of glass G. to
keep the parts. AB at a proper distance
so that they may slide within 1/2 an
inch of each other if required. Then con-
nect the chains belonging to the sliding
wires with the hook of the battery, &
the discharging rod. Send the charge & a
battery through it. On making the
explosion, a spark will be seen between
A & B, which shows that the electric fluid
chooses rather a short passage through
the air than a long one through the
wire. The charge, however, does not
pass entirely through. A & B, but part of

it also goes through the wire, which may be proved by putting a slender wire between A + B for on making the discharge, with only this addition in the apparatus, the small wire will hardly be made red hot, where as if the large wire ABD be cut in D, so as to discontinue the circuit. A B D. the small wire will be melted & even exploded by the same shock that before made it scarcely red hot. In this manner the conducting power of different metals may be tried using metallic circuits of the same length & thickness, & observing the difference of the passage through them in each.

To swell Clay & break small
Tubes with Electric

Explosion. (Fig 22.)

Roll up a piece of soft tobacco pipe
clay in a small cylinder CD, & insert
in it 2 wires AB, so that their ends
within the clay may be about $\frac{1}{5}$ of
an inch from one another. If a shock
be sent through this clay, by connect-
ing one of the wires A or B with the
outside of a charged jar, & the other with
the inside it will be inflated by the
shock i.e. by the spark that passes
between the 2 wires, & after the explosion
will appear as represented, if
the shock sent through it is } Fig 23.

too strong, & the clay not very moist
it will be broken by the explosion
& its fragments scattered in every
direction.

To make this experiment with a
little variation, take a piece of the
tube of tobacco pipe, about 1 inch
long, & fill its bore with moist clay
then insert in it 2 wires, as in the above
rolled clay, send a shock through it.

This tube will not fail to burst by
the force of the explosion, & its fragments
will be scattered about to a great distance.
If instead of clay, the above mentioned
tube of the tobacco pipe, or glass tube (which
will answer as well) be filled with any
other substance, either electric or non electric
inferior to metal, on making the discharge
it will be broken in pieces with nearly the same
force.

An Electrometer: { Fig 13
Which consists of a lined thread, having
at a small cork, or pith ball. This elec-
trometer is suspended by the middle of
the thread, on any conductor proper
for the purpose. It serves to shew the
kind & quantity of its electricity, by
applying a stick of sealing wax excited,
or an excited smooth glass tube to the
balls, which will recede or collapse when
the above wax or tube are applied alter-
nately. By this means it will shew
whether the conductor be charged positively
or negatively: for if be charged positively
by applying the excited glass, the balls
will recede still further asunder, & on
applying the excited wax, they collapse
together.

The Universal Discharger:

Which is of extensive use, is composed of the following parts: { Fig 8.

A is a flat board 15 inches long, 4 inches broad & 1 thick, or thereabouts, which forms the basis of the instrument.

B B are 2 glass pillars cemented in 2 holes upon the board A, furnished at the tops with brass caps each of which has a turning joint, & supports a spring tube, through which the wire DC slides. Each of these caps is composed of 3 pieces of brass, connected so that the wire DC besides its sliding through the socket has 2 other motions, viz an horizontal and a vertical one. Each of the wires DC, DC', is furnished with an open ring at one end, & at the other

end has a brass ball, D. which by a short spring socket, is slipped upon its pointed extremity, & may be removed from it at pleasure. E is a strong circular piece of wood 5 inches in diameter, having on its surface, a slip of ivory inlaid, & furnished with a strong cylindrical foot, which fits the cavity of the socket F, which is fastened in the middle of the board & has a screw G, which serves to fasten the foot of the circular board E at any required height.

To prove that the Electric Spark displaces & rarefies the Air.

The electrical thermometer being very useful to observe the effects of electric explosion upon air, the body of Exper 8. This thermometer consists of a  Fig 24.

glass tube, A.B, about 10 inches long,
nearly 2 inches in diameter; sealed air-
tight at both ends by 2 brass caps, Through
a hole in the upper cap, a small tube,
H.A, open at both ends, is introduced in
some water, at the bottom B. in the large
tube. Through the middle of each of the
brass caps, a wire F.G.E.I is introduced, hav-
ing a brass knob within the glass tube, by
sliding through the caps, they may be set
at any distance from each other. This
instrument is, by a brass ring C, fastened
to the pillar of the wooden stand ^{CD} that sup-
ports it. When the air within the tube
A.B is rarefied, it will press upon the water
at the bottom of the tube, which will conse-
quently rise in the cavity of the small tube;
as this water rises higher or lower, so it shews

the greater or less rarefaction of the air within the tube AB, which has no communication with the external air.

Bring the knobs GI of the wires IE, FG, when this instrument is to be used, into contact with each other, then connect the ring E or F with one side of a charged jar, & the other ring with the other side of the tube. By which operation a shock will be made to pass through the wires IG, IE, i.e. between the knobs GI. In this case you will observe that the water in the small tube is not at all moved from the mark; which shows that the passage of the electric fluid, through conductors sufficiently large, occasions no rarefaction, nor displaces the air about them.

Put the knobs GI a little distance from one another, & send a shock through them as before. You will see, that the spark between them may be fixed.

The 2 knobs, not only displace, but rarefy considerably the air, for the water will be suddenly pushed almost at the top of the small tube. Immediately it will subside a little; as for instance as far as H ; which is occasioned by the sudden displacing, & replacing of the air about the place where the spark appeared within the tube AB . After that the water has subsided suddenly from the first rising, it will then gradually & slowly come down to the mark at which it stood before the explosion; which is the effect of the air that was rarefied, & which gradually returns to its former temperature.

be made in a room.
If this experiment, where the degree of heat is variable, then proper allowance must be made for this circumstance, in estimating the event of this experiment; for the electrical air thermometer is affected by

heat or cold in general, as well as by that caused by an electric spark.

The Course of the Electric Fluid in the Discharge, rendered visible by the Star and Pencil.

When a jar is charged, take a discharging rod having its ends pointed i.e. the discharging rod represented in { Fig 13. Fig 14, without its knobs, & keep it as represented. Fig 15 i.e. in such a situation, that one of its points C may be at about 1 inch distance from the knob A, & the other point B, at an equal distance from the outside coating of the jar: by these means the jar will be silently discharged; & if its inside be electrified positively, you will see that the point of the discharging ^{rod} is illuminated with a star, the point B with a pencil; because, in this case,

the electric fluid, going from the inside to the outside of the jar, enters the point C. & issues from the point B. But if the jar is electrified negatively on the inside, & consequently positive on the outside, then the pencil of rays will appear upon the point C, & the star upon the point B: for in this case the electric fluid passes from the outside to the inside of the jar. This experiment, as well as any other in which the electric light is to be observed, requires to be made in the dark.

Exper 9.) The Leyden Vacuum. (Fig 20.)
A small phial coated on the outside about 3 inches up the side with tin foil, at the top of the neck of this phial a brass cap is cemented, having a hole with a valve: from the cap a wire proceeds a few inches within the phial, terminating

in a blunt point. When this phial is exhausted of air, a brass ball is scued upon the cap, which is cemented into its neck, so as to defend the valve, & prevent any air from getting into the exhausted glass. The inside of this phial requires no coating, because, as the electric fluid pervades vacuum, it can pass freely from the wire to the surface of the exhausted glass, without the help of a non-electric coating. This phial exhibits clearly the direction of the electric fluid both in charging & discharging: for if it be held by its bottom, & its brass knob be presented to the prime conductor positively electrified, you will see that the electric fluid causeth the pencil of rays to proceed from the wire (Fig 21. within the phial as represented, & if it is discharged, a star will appear in the place of the pencil as represented in Fig 20.

But if the phial is held by the brass cap, & its bottom be touched by the prime conductor, then the point of the wire on its side will appear illuminated with a star when charging, & with a pencil when discharging. If it be presented to a prime conductor electrified negatively, all these appearances both in charging & discharging will be reversed.

This experiment of the Leyden vacuum, exhibits an ocular demonstration of the hypothesis of a single electric fluid.

To make the Electric Spark visible in Water. Exper 10.

Fill a glass tube of about 1/2 an inch diameter, & 6 inches long, with water, & to each extremities of the tube adapt a cork, which may confine the water; through

each cork insert a blunt wire, so that the extremities of the wires, within the tube, may be very near one another; lastly connect one of these phials with the coating of a small charged phial, touch the other wire with the the knot of it; by which means the shock will pass through the wires, & cause a vivid spark to appear between their extremities within the tube. In performing this experiment, care must be taken that the charge be exceedingly weak, otherwise the tube will burst.

In a common drinking glass almost full of water, immerse AB, which { Fig 17. are 2 knotted wires so bent, that their knobs may be within a little distance of one another in the water. If one of these wires be connected with the

outside coating of a pretty large jar, & the other wire be touched with the end of it, the explosion which must pass through the water from the knob of one of the wires to that of the other, will disperse the water, & break the glass with a surprising violence. This experiment is very dangerous, if not conducted with great caution.

The Powder House, { Plate 4.
Fig 3.
Is an ingenious contrivance, & well adapted to the purpose: the front is fitted up like the Thunder house: it is generally 7 or 8 inches long, & nearly the same height to the top of the roof: the side & that half the roof next the eye, is omitted in the figure, that the

inside may be more conveniently seen
The sides, back, & front of the house are
joined to the bottom by hinges; the roof
is divided into 2 parts, which are also
fastened to the sides by hinges, the build-
ing is kept together by a ridge fixed
half way on one side of the roof so that
when the building is put together, the
other half of the ridge laps over the
other half of the roof, & holds it together.

Within the house there is a brass
tube $1\frac{1}{2}$ inches long & $\frac{5}{8}$ of an inch
in diameter, secured on a pedestal
of wood; into the side of this brass tube
is screwed a wire, which goes thro' $\frac{1}{8}$ of
an inch or better; the other end, by
means of a chain, has a commu-
nication to the hook D; at the other
side of the tube a piece of ivory, such

long, is screwed, with a small hole for the wire to slide into. it

To use this apparatus, fill the glass tube A with gunpowder, insert the wire B a small way into the ivory tube, then connect the hook C with the bottom of a large ^{jar} or battery, when the jar &c. is charged, form a communication from the hook D to the top of the jar &c. the discharge will then take place, & the explosion of the gunpowder will throw asunder the roof, & the sides, the front & back will then fall down.

The Pyramid,

Fig. 11.

It is designed to shew the same experiments as the Thunder house, & is used in the same manner. When the piece A

is thrown out by the discharge. The upper part of the pyramid falls down, it is usually made to represent a stone steeple. It is composed of several pieces; by which means, there appears greater devastation.

The Luminous Word. Fig 5.
This experiment is exactly on the same principle as Fig. 18 & 19. Plate 3. The word is formed by the small separations made in the tin foil; if they were cut a little round at every division, the spark by that means would appear more vivid as it passed along the windings. It may be observed in making these experiments, that the longer any word is, & the oftener the tin foil is cut, the more powerful the machine must be, in order to convey the spark from one end to the other because they

every time the passage is interrupted by cutting, the space is increased; in long conveyances the space will amount to more than the machine will be able to overcome. Therefore the shorter the illuminations are, the more pleasing they will appear.

To shew how a jar charges & discharges. Coat a jar as represented, by { Fig 6. pasting small pieces of tin foil at a little distance from each other round its exterior surface. As this jar is charging small sparks will pass from one piece of tin foil to another, in a variety of directions; the separation of the tin foil is the means of making the passage of the fluid, from the outside of the jar, to the table, visible. Discharge this jar by bringing a pointed wire gradually near the brass ball

The uncoated part of the glass, between the pieces of tin foil, will be pleasantly illuminated, & make a crackling noise: but if the jar is discharged suddenly, the whole outside surface will appear illuminated. The glass must be very dry to produce these appearances, to the greatest advantage.

How to make Inflammable Air
that will take Fire by the Electric
Spark. Fig 8.

Procure 2 bottles, as represented A D, in the bottle D put about 2 or 3 oz of iron filings, to which put some oil of vitriol mixed with 10 times its quantity of water, fill the bottle A with water, & fix the bent glass pipe C air tight into the bottle D, & the other end a little way up the neck of the bottle A, in a short time the mixture will boil, & emit a

fluid, which will pass through the
bended tube C into the bottle A, & will
at last fill it, expelling the water into the
basin B. The bottle A is then expedi-
tiously corked up for use.

The Electrical Pistol Fig 9

Is represented by a, b, c, d, e, - c, d, is made of
thin brass; to the mouth a, b, a cork is fitted;
& a perforated piece of brass e, screws on the
bottom of the pistol at c, having a glass
tube with a wire cemented into it, ben-
ded over the glass tube, so as to reach within
 $\frac{1}{8}$ of an inch of the brass; when the pistol
is to be charged uncork the inflammable
air bottle, likewise the pistol, & place the
mouth of the pistol upon the top of the
bottle. The common air which is in the
pistol will descend while the other ascends;
keep the pistol in this situation a few
seconds, according to the strength of the

inflammable air. then expeditiously
cork both the bottle & pistol. It is
charged. To discharge it fill a small
jar or a hollow handle, & apply it to
the little knob of the wire, it will
then explode, & drive out the cork to
a considerable distance, making as
loud a report as a pistol filled with
gunpowder.

The Construction of a simple
Orery put into Motion by Electric
city. Plate 5. Fig 1.

This orery is for shewing the earth's
motion round its axis in 24 hours,
the age of the moon from change to
change, & all her various phases during
that time. A is the horizontal board, or
stand of this machine, & B is the great
wheel, with 18 floats or wings for the

electric stream to act upon, turn
the wheel according to the order of
the letters a, b, c, d. On the axis of this
wheel is a tumbler C, of 8 Staves, for
turning the wheel E, of 32 teeth, on
whose axis is the tumbler G, of 8 staves
for turning the wheel H, of 59 teeth,
which will go once round in the time
the great wheel A, goes $29\frac{1}{2}$. A little
hollow globe D, representing the earth,
with its meridians, equator, tropics, po-
lar circles, & poles, is put upon the top of
the axis of the great wheel A, & on the
same axis is an index F, which goes
round a small dial plate c of 24
hours, in the time that the earth D
turns round. And an ivory ball I is
placed on the top of the axis of the wheel

H, half black, half white to represent the moon, below which, on the same axis, is an index K, which goes round a small plate & divided into $29\frac{1}{2}$ equal parts for the days of the moons age from change to change. So that, in the time the great wheel A, the earth D, & the hour index E, make $29\frac{1}{2}$ revolutions, the moon I & her index K make only one; & in that time, by shewing all round to the observers, they see all her different phases or appearances, like those of the real moon in the heavens.

Having set the orery near the prime conductor, place a crooked wire from the conductor, so as its point may be even with the great wheel B, & tend to turn it in the direction a, b, c, d, & turn

the glass globe of the electrical machine
by the winch, & a stream of fire will
issue from the wire to the wheel, & turn
the whole of the moveable work; by
which means, the earth D will be
turned round its axis, from west by
south to east: & in such turn of the
earth, the index E. will go round all
the 24 hours on the dial plate e.

In the time the earth & index will
turn $29\frac{1}{2}$ times round, the moon I
will turn round her axis, showing
all her various phases; & the index K
will go over all the $29\frac{1}{2}$ days of the
moons age on the plate K.

A Model of a Water Mill turned
by a stream of Electric Fire.

A Model of the common mill { Fig 2
for grinding corn. A is a water
wheel, B the cog wheel on its axis, C the
trundle turned by that wheel, & D the
running mill stone, on the top of the
axis of the trundle. It may easily be
contrived & turned also by electricity,
if instead of the round plate D for
the mill stone, there be a horizontal
wheel on the axis of the trundle C with
spur cogs, which will turn 2 trundles
placed on its opposite sides; & on the
top of each of these trundles axis, may
be a round plate representing a mill
stone; so that this model has all the
parts of a double water mill, turning
2 mill stones. Exper. 12.

Set the mill near the prime conductor, & place the crooked wire so that its point may be directed toward the uppermost side of the great wheel A. Then turn the glass globe by the winch, & the stream of fire that issues from the point of the wire will turn the wheel; & consequently all the other working parts of the mill.

Another Electrical Overy, shewing the motion of the Sun, Earth, and Moon. Fig 3.

The sun & earth go round the common center of gravity between them in a solar year; & the earth & moon go round the common center of gravity between them in a lunar month. These motions are represented by an electrical experiment as follows.

The ball *S* represents the sun, *E* the earth,
& *M* the moon, connected by wire *a, c*,
& *b, d*: *a* is the center of gravity between
the sun & the earth, & *b* is the center of
gravity between the earth & moon.

These 3 balls & their connecting wires, are
hung & supported on the sharp point
of a wire *A*, which is stuck upright
in the prime conductor *B* of the elec-
trical machine; the earth & moon hang-
ing upon the sharp point of the wire
c, a, c, in which wire is a pointed short
pin, sticking out horizontally at *c*; &
there is just such another one at *a*,
sticking out in the same manner,
in the wire that connects the earth
& moon.

Expt 13.

When the globe of the electrical machine is turned, the above mentioned balls & wires are electrified: & the electrical fire, flying off horizontally from the point c & d, cause S & E to move round their common center of gravity b, And as E & M are light when compared to S & E, there is much less friction on the point b than upon the point a; so that E & M will make more revolutions about the point b, than S & E make about the point a. The weights of the balls may be adjusted so, that E & M may go 12 times round b in the time that S & E go once round a. It makes a good amusing experiment in electricity; but it is so far from proving that the motions of the planet in

the heavens are owing to a like cause
that it plainly proves they are not;
for the real sun & planets are not con-
nected by wires or bars of metal: con-
sequently there can be no such metallic
points as c & d between them. And with-
out such points, the electric fluid would
never cause them to move, for take
away these points in the above men-
tioned experiment, & the balls will
continue at rest, let them be ever so
strongly electrified.

Fig 6.

The electrified Capillary Syphon.

Let a small bucket of metal, full
of water, be suspended from the prime
conductor, & put in it a glass syphon,
of so narrow extremity as the water

will just drop from it. If in this disposition of the apparatus the winch of the machine is turned, the water, which, when not electrified, only drops from the extremity of the syphon, will now run in a full stream, which will even be subdivided into other smaller streams. If the experiment be made in the dark, it will be beautifully illuminated, & like a fountain with streams of fire; which may be made to stop apparently by word of command, by touching the prime conductor.

The Quadrant Electrometer.

The only instrument that { Figs
can with propriety be called

an electrometer; that is - such as measures the precise degree to which any body is electrified, is as follows: A is a very light rod, that turns on the center of a semicircle B, so as always to keep pretty near its graduated limb; at the extremity of the rod is a cork ball C. D is the pillar that supports the rod. I may be either fixed to the prime conductor, or let into the brass knob of a jar or battery, or may be set on a stand to support itself. The whole instrument may be made of box or ivory: but it is most perfect when the pillar & rod are made of box, made very smooth with emery paper: the ball of cork, & the semicircle ivory, as the divisions on that are more legible than on wood.

The moment this instrument begins to be electrified, the rod is repelled by the pillar, & consequently begins to move over the edge of the semicircle, & shews to the greatest precision, the degree to which the prime conductor is electrified; or how high any jar or battery is charged. As the materials of which this instrument is made are very imperfect conductors, it will very rarely dissipate any of the electricity of the prime conductor &c. with which it is connected: but if it be found, by a trial in the dark, that any part of it collects the electric matter, it must be placed before the fire to dry off the damp, particularly from the index: it should not however ever be much heated, for then it

will not receive the electricity ready enough. The motion of the index will not answer with sufficient accuracy to the degree of electricity in the body with which it is in contact: but this inconvenience may be easily remedied by moistening the pillar index; for the semicircle can never be too dry.

It is evident from the construction of the instrument, that the force of different explosions may be ascertained by it before the discharge, with the greatest accuracy.

If a jar be charged with positive electricity, you want to know the precise time, while you are attempting to charge it negatively, that is become discharged, watch the moment the index comes to the perpendicular station, which may be observed

without the least danger of a mis-
take, you will then find that there is
not the least spark left in the jar.

If you continue the operation, the index
will begin to advance again, there-
by shew the exact quantity of the op-
posite electricity the jar has acquired.

A very useful Instrument to cure
the Tooth Ach. Fig 5.

The instrument A is a flat square
piece of box wood, about 1 inch broad, &
 $\frac{1}{4}$ of an inch in thickness. 2 Longitudi-
nal holes are made quite through it
near its opposite edges, through which
the brass wires a b c. & d e f. are put while
they are straight: then fixed with seal-
ing wax, & bent as in the figure so as to

receive the tooth & gum between their points c & f, which must not be made too sharp for fear of hurting the gum. When it is used, 2 chains g & h must be hooked to the other ends of the wires, & holding it on the gum, with the tooth between the ends of c & f of the wires a b c & d e f, hook the chains g & h on the other ends of these wires; put the other end of a chain g round the bottom of a jar, & cause an assistant to hold the chain h, hanging down from his hand; the chains not touching one another, & both of them clear of the table. Then having charged the jar, desire the assistant to strike the prime conductor with the loose end of the chain h. This will discharge the jar & give the person a shock, which will be felt only in the tooth & gum that is taken in between the wires at c & f.

Practical Rules concerning the Use of the Electrical Apparatus and the performing of Experiments.

It often happens that young electricians are at a loss to assign the reason why some experiments do not succeed with them, as described in the Treatise on Electricity. Sometimes they are provided of very good instruments, but by reason of some circumstance or other unattended to. They are quite useless in their hands. This indeed can be remedied by nothing but practice: & it is by long use that electricians, as well as practitioners in any art or science, becomes so good operators, as to use their instruments to the best advantage. A few rules are

however necessary to guide him in his operations, & although these alone are insufficient to make a person a complete practical electrician, yet when accompanied with the actual management of the apparatus, they facilitate the use of it, render the performance of the experiments more accurate & expeditious.

The first thing that the young electrician should observe is, the preservation & care of his instruments. The electrical machine, the coated jars, &c. in short, every part of the electrical apparatus, should be kept clean, & as free as possible from dust & moisture.

When the weather is clear, & the air dry, especially in clear & frosty weather, the electrical machine will always work

well; But when the weather is very hot, the machine is not so powerful; nor in damp weather except it be brought into a warm room, & the cylinder, the stands, the jars, &c. be made thoroughly dry.

Before the machine is used, the cylinder should be first wiped very clean with a soft linen cloth that is dry, clean, & warm; afterwards with a clean hot flannel, or an old silk handkerchief. This done apply a little amalgam to the winch. It will soon be perceived that the electric fluid will come from the cylinder like a wind, to the knuckle: & if the motion be a little continued, sparks & crackling will soon follow. This indicates that the machine is in good order: & the electrician may

proceed to perform his experiments.

But if, when the wrench is turned for some time, no wind is felt upon the knuckle, then the fault is, very likely, in the rubber; to remedy that use the following directions: By unscrewing the screws on the back of the rubber, remove it from its glass pillar, & keep it a little near the fire, so that its silk part may be dried: take now a piece of dry mutton seet, or a little tallow from the candle, just pass it over the leather of the rubber, & then the machine can not fail to be fit for use.

Sometimes the machine will not work well, because the rubber is not sufficiently supplied with electric fluid: which happens when the table upon which the machine stands, &c. which

the chain of the rubber is connected, is very dry, & consequently in a bad conducting state. Even the floor & the walls of the room are, in very dry weather, bad conductors, & they cannot supply the rubber sufficiently. In this case, the best expedient is, to connect the chain of the rubber by means of a long wire, with some moist ground, or with the iron work of a water pump: by which means the rubber, will be supplied with as much electric fluid as is required.

When a sufficient quantity of amalgam has been accumulated upon the leather of the rubber, the machine does not work very well. Then, instead of putting more amalgam, it will

be sufficient, to take the rubber off, & to scrape a little off that which is already upon the leather.

It will be often observed, that the globe or cylinder, after being used some time contracts some black spots, occasioned by the amalgam, or some foulness of the rubber, which grows continually larger, & greatly obstructs its electric power.

These spots must be carefully taken off, & the cylinder must be frequently wiped, in order to prevent its contracting them.

In charging electric jars in general it must be observed, that every machine will not charge them equally high. That machine whose electric power is the strongest, will always charge the

jars the highest. If the coated jars
before they are used, be made a little
warmer, they will receive, & hold the
charge the better.

If several jars are connected together
among which there is one which is apt
to discharge itself very soon, then the
other jars will also be soon discharged
with that; although they may be
capable of holding a very great charge
by themselves. When electric jars are to
be discharged, the electrician must
be cautious lest by some circumstance
not adverted to, the shock should pass
through any part of his body; for an
unexpected shock, though not very strong,
may occasion several disagreeable acci-
dents. In making the discharge, care must
be taken that the discharging rod be not

placed on the thinnest part of the glass: for that may cause the bursting of the jar.

When a large battery is discharged, jars will be often found broken in it, which burst at the time of the discharge.

To remedy this inconvenience take this method: which is, never to discharge the battery through a good conductor, except the circuit be at least 5 ft. long. Mr. Vairne says, that ever since he made use of this precaution, he has discharged a very large battery near 100 times, without ever breaking a single jar; whereas before, he was continually breaking them. But here it must be considered, that the length of the circuit weakens the force of the shock proportionably: the highest degree of which is in many experiments required.

It is advisable when a jar, especially a battery, has been discharged, not to touch its wires with the hand before the discharging rod be applied to its sides a 2nd & even a 3rd time; as there generally remains a residuum of the charge. This residuum is occasioned by the electricity, that, when the jar is charging, spreads itself over the uncoated part of the glass near the coating, which will not be discharged at first, but gradually returns to the coating after the first discharge, which is sometimes very considerable.

When any experiment is to be performed, which requires but a small part of the apparatus, the remaining of it should be placed at a distance from

The machine, the prime conductor, even from the table if that is not very large. Candles, particularly, at a considerable distance from the prime conductor: for the effluvia of their flames carry off much of the electric fluid.

Lastly. The young electrician, cautioned not to depend on first appearances in electricity. A new phenomenon may justly excite his curiosity, it is laudable to remark it. To pursue the hint; but at the same time even the doubtful assertion of a new fact should never be made, till after a number of concerning similar experiments. Electricity is a science that

often deceives the senses; & the most experienced electrician frequently finds himself mistaken in things, which perhaps he may have before considered as most certain.

Plate C. Fig 1.

In many electrical experiments, it is very convenient to have a method of determining, whether a small degree of electricity be positive or negative; In using large batteries, it is a matter of consequence to know how the charge advances, & of what strength it is. Mr Canton's balls are extremely useful for both these purposes. They are made of the pith of elder, turned perfectly globular, & suspended from the conductor by fine threads. To understand the use of them, suppose a jar or battery stands

upon the table, I want to know whether the inside be charged positively or negatively. In order to this, I present the balls, they are immediately attracted by the wire, & diverge from one another. This is common to both electricities; the greater the distance to which the balls separate, the farther they repel one another, the higher is the charge. To determine of what kind it is, I rub a piece of glass against my hand or coat, which I know will excite it positively, & then present it to the balls in their diverging state. If it makes the balls converge, & consequently avoid the glass, it shows that they are electrified positively as well as the glass. On the contrary, if it increase their divergency, & attract them, it shows their

electricity to be of a kind opposite to that of the glass; that is, negative. And it must be remembered that the electricity of the balls (which cannot touch, or receive any electricity from the wires of the jar, or battery) is always contrary to that with which they are charged: for all bodies placed within the influence of electrified bodies, are affected with the contrary electricity.

In order to ascertain the kind of an exceedingly small degree of electricity, it will be convenient to have a very light body; as a piece of downy ^{feather} hanging by a silken thread. This light body, when it is once electrified, either positively, or negatively, will retain its virtue a long time with very little

loss. If then any body (the electricity of which is unknown) be brought to it, the feather will be repelled by it, if it be of the same kind with its own, & attracted if it be the contrary to it. The silk by which it is suspended, should be a single thread, as it comes from the worms; or at least a very few of those threads. The whole should be as light as possible.

The Electrophorus.

It consists of 2 plates, ^{A & B,} made of a circular form, from 6 to 8 inches in diameter, or upwards. The upper plate is generally made of brass, but a tin plate with a wire turned up on its edge, will answer exceedingly well. At the center of this plate there is a socket ^o, in which a glass handle *F* (9 or 10 inches long) is fixed. A thin

board, covered with tin foil, & suspended by silken threads, will answer well when the electrophorus, is wanted of a large diameter.

The under plate may be made of glass, sealing wax, or of the following composition, viz. 1 part Rosin, 3 parts pitch, 3 parts shellac, 2 parts Venice turpentine, melted together over a gentle fire. It may be poured & spread upon a thin linen cloth about $\frac{1}{4}$ of an inch thick. The linen cloth must be stretched upon a hoop & made as tight as possible. If the surface be a little rough, it will be no worse.

The manner of using this machine is as follows: Rub the coated side of the under plate A with a fine new flannel, or a hare or cats skin & when it is exci

ted as much as possible, set it on a table, & place the upper plate upon it, & put your finger on the upper plate: then take your finger off & take hold of the top of the glass handle E, & apply it to the knob of a coated jar. Repeat this operation for 30 or 40 times, & the jar will become charged.

Mr Cavallo mentions one of the above kind which he made, with which he charged a coated phial several times (by once exciting) so strong as to pierce a hole through a card at every discharge.

When a glass is coated with sealing wax, after it is excited & laid with the waxed side downwards & the glass uppermost, then on making the usual experiment of putting the

metal plate on it, & taking the
spark, &c. it will be attended with
contrary electricity to what it had
before.

Medical Electricity.

Before we conclude the subject,
it will be necessary to give some
rules, in order to explain a few prac-
tical experiments of applying medi-
cal electricity: First, It should be
attentively observed, to apply the mal-
lest force of electricity, which may
be sufficient to remove or alleviate
any disorder. The chief difficulty con-
sists in distinguishing the proper
strength of the electric power that
is required for a ^{given} disorder. The
sex & condition of the patient must
be duly considered; & in regard to this

point, it is impossible to give any exact & invariable rules; the circumstances being of such a nature, so various, that long experience, & a strict attention to every particular phenomenon, are the only means by which proper instructions may be received. The surest rule that can be given relating to this particular, is to begin with the most gentle treatment; at least such that, considering the constitution of the patient, may be thought rather weak than strong. When this gentle treatment has been found ineffectual for a few days, which is denoted by the disease not abating, & the application of electricity not causing any material alteration, then the operator may gradually increase the force of electricity until he finds the proper degree of it.

In judging of cases proper to be electrified, experience shows, that in general, all kinds of obstructions, whether of motion, of circulation, or of secretion, are very often removed or alleviated by electricity. The same may also be said of nervous disorders; both which include a great variety of disorders. The application of electricity has also been found very beneficial in diseases of a long standing. It has likewise been found a powerful remedy in muscular contractions. But when any limb of the body is deprived of motion, it must be observed, that the deprivation of motion is not always originated by a contraction of the muscle, but that it is often occasioned by a relaxation; thus, for instance, if the hand is bent inwardly, the patient has

no power of straightening it; the cause of it may be a weakness of the outward muscles, as well as a contraction of the inward ones. In such cases it is often difficult, even for good anatomists to discover the real cause; but the surest method is to electrify, not only those muscles which are supposed to be contracted; but also their antagonists; for to electrify a sound muscle is by no means hurtful.

Rheumatic disorders, even of long standing, are relieved, & generally quite cured, by only drawing the electric fluid with a point from the part, or by drawing sparks from the conductor; the operation should be continued for about 4 or 5 minutes, repeating it once or twice every day.

When strong shocks are administered, their greatest number should not exceed 12 or 14, except when they are given to the whole body in different directions.

The instruments which, beside the electrical machine, its prime conductor, are necessary for the administration of medical electricity may be reduced to 3, viz. an electrical jar, W Lanes electrometer, an insulated chair, or stool, & the directors.

Fig. 4. represents the electrical jar, with W Lanes electrometer, & the manner in which the shocks are sent thro' any part of the body. The surface of the jar, which is coated with tin foil, should be about 14 inches in diameter,

16 inches high, which is equal to a
bout 73 square inches. The brass wire,
which passes thro' the covering of the jar,
& touches the inside coating, has a brass
ball E' to which the electrometer F
 DE is fastened: & proceeding a little
farther up. terminates in another brass
ball B , which should be so high as
to touch the prime conductor A , which
is supposed to stand before the electri-
cal machine. The electrometer con-
sists of a glass stick, FD , cemented
to 2 brass caps $E' + D$; from the latter
of which a strong perpendicular brass
wire proceeds, the extremity of which
comes as high as the center of the ball B ,
& is furnished with an horizontal spring
socket, through which the wire CE , having
the brass ball C at one end, & the open

ring E' at the other, may be slid back
wards & forwards, so as to set the brass ball
 C at any required distance from the ball
 B . This distance, at most, need not be
greater than $\frac{1}{10}$ of an inch; hence the electro-
meter may be made very small. Some-
times small divisions are marked upon
the wire CE , which serve to set the balls
 B & C at a given distance from one another
with more readiness & precision. Now, sup-
pose that the jar is set contiguous to the
prime conductor; that is, with the ball
 B touching the conductor; that the ball
 C be set $\frac{1}{10}$ of an inch distant from the
ball B ; that, by means of a chain, a
conducting communication be formed
from E' to the outside coating of the jar,
by a chain x . In this case, if the elec-
trical machine be put in motion,

the jar will be charged; & when the charge is so high as that the electric fluid accumulated within the jar can leap from the ball B to C, which we have supposed to be $\frac{1}{10}$ of an inch asunder, the discharge will happen, & a spark appear between the said balls, & the shock passes through the chain x: for the part F D of the electrometer being of glass, generally covered with sealing wax, is impervious to electricity, consequently the electric fluid has no other way through which it can pass from the inside to the outside of the glass jar. When the shocks are to be given with this apparatus to any particular part of the body (for instance, to the arm) then, instead of the chain x, which must now be taken away, 2 slender & flexible wires, F I, I,

HL, one to be fastened, one to the opening E of the electrometer, & to the brass hook F of the stand HH, which communicates with the outside coating of the jar. If the jar has not the stand HH, the extremity F of the wire HL may be simply rested under, or may be tied round it. In short, it must be put in contact with the outside coating of the jar, in any convenient manner. The other extremities of the said wires are fastened each to the brass wires L, & L of the directors KI, KI. Each of those instruments, justly called directors, consists of a knobbed brass wire L, which by means of a brass cap is cemented to the glass handle K. The operators holding them by the extremity of the glass handle, brings their ball into contact with

the extremities of that part of the body of the patient through which he desires to send the shock. The management & convenience of this apparatus are easily comprehended by inspecting the figures; for when the machine is in motion, & the apparatus, &c. is situated as in the figure, the discharge of the jars must be evidently made through that part of the patient's arm which lies between the knobs of the directors. The operator, whilst an assistant keeps the machine in motion, has nothing more to do than to hold the knobs of the directors to the extremities of the arm, or to any other part of the body that is required to be thus electrified; always taking care that the 2 wires E.L., H., do not touch each

other, because in that case the shock will not pass through that part of the body that is required to be electrified. Thus any number of shocks, precisely of the same strength, may be given, without altering any part of the apparatus, or having any farther trouble: When the strength of the shocks is required to be diminished or increased, it is only precisely to diminish or augment the distance between the balls BC; which is done by slipping the wire CE forwards or backwards through the spring socket that holds it.

It is almost needless to mention, that when shocks are administered, it is immaterial whether the patient stands upon the ground, or upon the insulated stools or in any other situation whatever. Neither is

it always necessary to remove the clothes from the part that is to be electrified, in order to let the knobs of the directors touch the skin; for, except the coverings be too many, & too thick, in which case part of them at least should be removed, the shocks will go through them very easily, especially if the knobs of the directors be pressed a little upon the part.

Of the Technical Terms used by Writers on the subject of Electricity.

Battery, electrical, a number of jars combined together so that they may be charged & discharged at the same time.

Charging, throwing an additional quantity of electric matter upon one side of a plate of glass, or a jar, while the other is exhausted in the same proportion. All other electric substances are capable of being charged as well as glass.

Circuit, electric, those conducting substances which are made use of to form a communication between the 2 coatings of a charged jar, or battery, &c. & through which the electric matter must pass, when the equilibrium between the 2 sides is restored by the discharge.

Coatings, plates of metal, or other conducting substances, laid upon plates of glass, or other electrics, whereby the additional quantity of electric matter, called the charge, may be the more easily & uniformly conveyed to them, or discharged from them.

Conductor, prime, a piece of metal furnished with points, to receive electric matter from the globe, after it has been excited by friction. It must always be insulated, or cut off from a communication with the earth by means of electric substances, such as glass, baked wood &c. Whenever the conductor is mentioned, the prime conductor must also be understood.

Conductors, or conducting substances, those bodies thro' which the electric matter may be transmitted. They are

also called *pyroelectrics*, because no electric power can be excited in them by friction.

Discharging, restoring the equilibrium of the electric fluid, after it has been disturbed by charging. It is effected by forming a communication between the overloaded & the exhausted side of a jar, battery &c, by means of conducting substances, through which the overplus or charge may pass from the one to the other. When the discharge is considerable, it is often attended with an explosion. *Discharging rod*, a brass rod, with a knob at each end, very convenient for either taking sparks from the prime conductor, or for discharging jars or batteries. It is sometimes bent into a semicircular form, in order to bring one of the

knobs to the outside, & the other to the
wire, communicating with the inside
of a charged jar, in order to discharge it
by receiving the explosion on the knob.

Electric matter, that subtle fluid
which is supposed to be the cause of all
those appearances which are termed elec-
tric. It is sometimes called electric fire,
sometimes ether.

Electrics, those bodies in which the
electric powers of attraction, repulsion &c.
may be excited by friction. They are
also called non conductors, because the
electric matter cannot pass thro' them.

Electrometers, instruments to measure
the degree of electrification; that is, the
quantity of electric matter shown upon
any body, or the force of an electric
explosion.

Excitation, the act of exciting or calling forth electric powers from electric substances by means of friction & other methods.

Insulating, placing bodies where they are not in contact with any conducting substance; as by suspending them in the air by silken strings; putting them on glass stands &c. so that the electricity they are charged with cannot be conveyed to the earth.

Penail, the appearance of electric light issuing from the point of a body electrified positively.

Negative Electricity, a less quantity of electric matter than is natural to any body.

Positive Electricity, a quantity of electric matter thrown upon any body, above its natural share.

Rubber, or cushion, a piece of leather, or any other substance against which the glass globe, or other electric body is whirled in the machine is rubbed in order to excite them.

Shock, electric, the convulsion given to the animal muscles by the passage of the electric matter through them, especially in the discharge of a jar or battery.

Star. The appearance of electric light from the point of a body electrified negatively.

Wire, of a phial, a jar, or battery, the wire or metal rod which goes into the phial, & which touches the inside coating. This wire is often put there for the inside coating.

To make Amalgam.

First, take spelter 11 ounces. Dissolve it in an iron ladle over a fire; let it cool a little, but not so as to become quite stiff. add to it while in that state, 6 ounces of mercury, & stir them well up together; then turn it out of the ladle upon a smooth stone & grind it with a muller till it becomes like a fine tough paste, which put in a box, & it is ready for use. If it should become too hard, grind it again with a little more mercury: the addition of a little tallow may be occasionally added.

Another.

Take of tin 1 pound; flour of sulphur 7 ounces; sal ammoniac & purified quick silver, of each $\frac{1}{2}$ a pound.

Melt the tin by itself, add to it the quick silver, & when the mixture is grown cold

reduce it into powder; mix this with
the sulphur & sal ammoniac, & sublimate
it in a matrass: the mercurial gold will
be found under the sublimated mat-
ter, with some drop at the bottom.
This is thought as powerful an amal-
gam as the former.

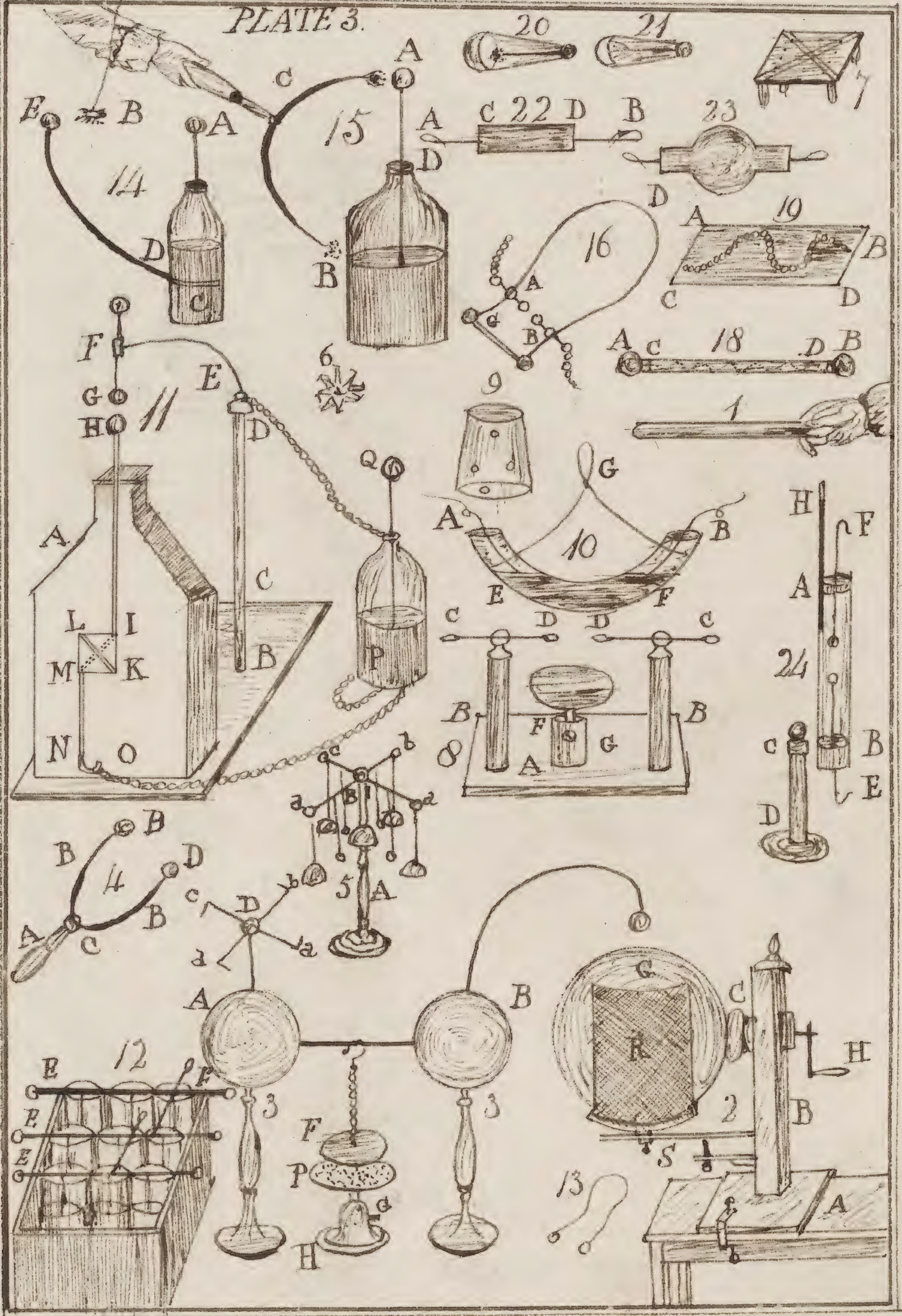
A composition for lining the
Inside of Globes or Cylinders.
Take 4 parts of Venice turpentine, 1 part
of rosin, & 1 of beeswax, boil the whole
over a gentle fire for 2 hours. It is fit
for use. When a globe or cylinder is to
be lined, it must be put into an oven,
with a sufficient quantity of the compo-
sition, broken & put in the inside. When
it is melted it must be turned round
every way, in order to spread it all over
equally. This lining has been found
to increase the electric power amazingly.

Mr Priestly used linseed oil & rosin in
the same manner as above directed.
the proportions was equal parts of each
boiled very well together.

A Varnish for all Parts of the
Machine which are
Insulated.

Take spirits of wine, highly rectified,
in it dissolve the best sealing wax
to a tolerable stiff consistence, with
which varnish over all your glass pil
lars, to keep off the moisture they at
tract from damp air.

PLATE 3.



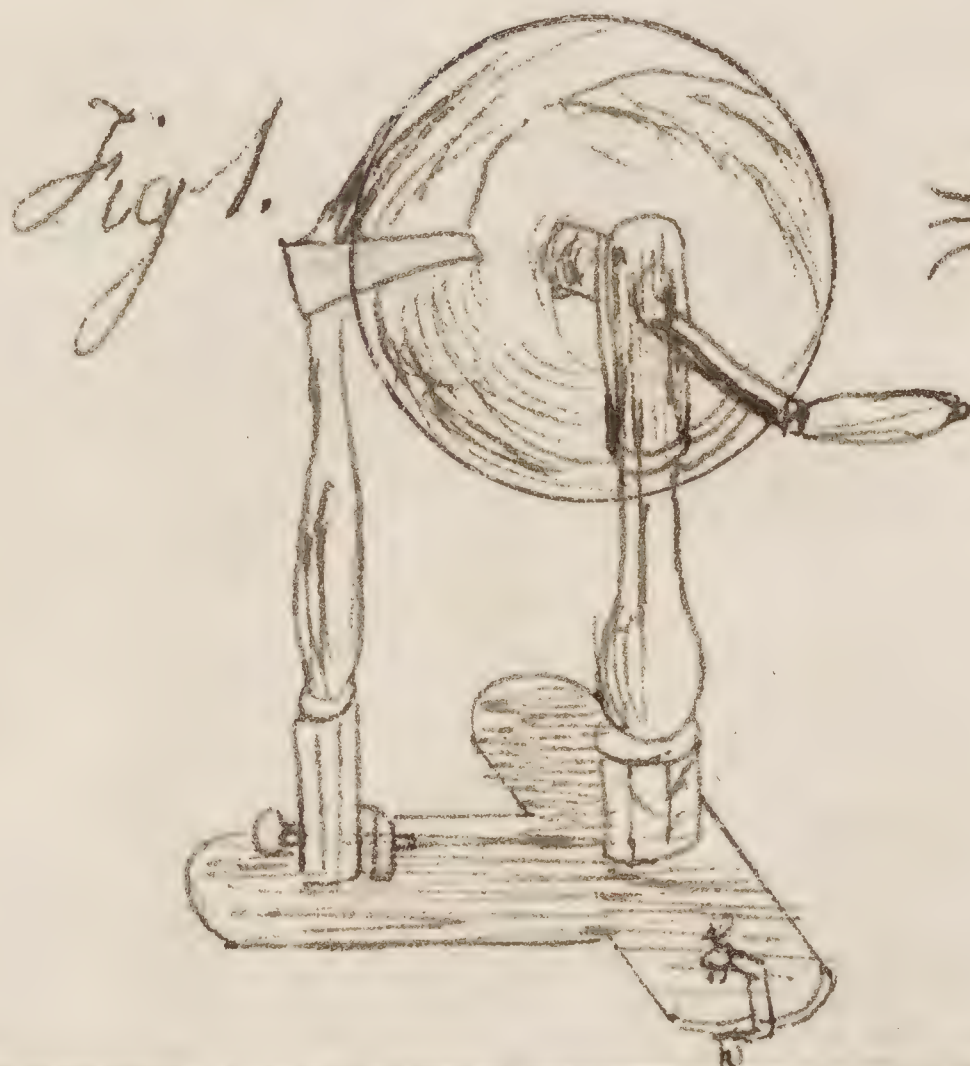
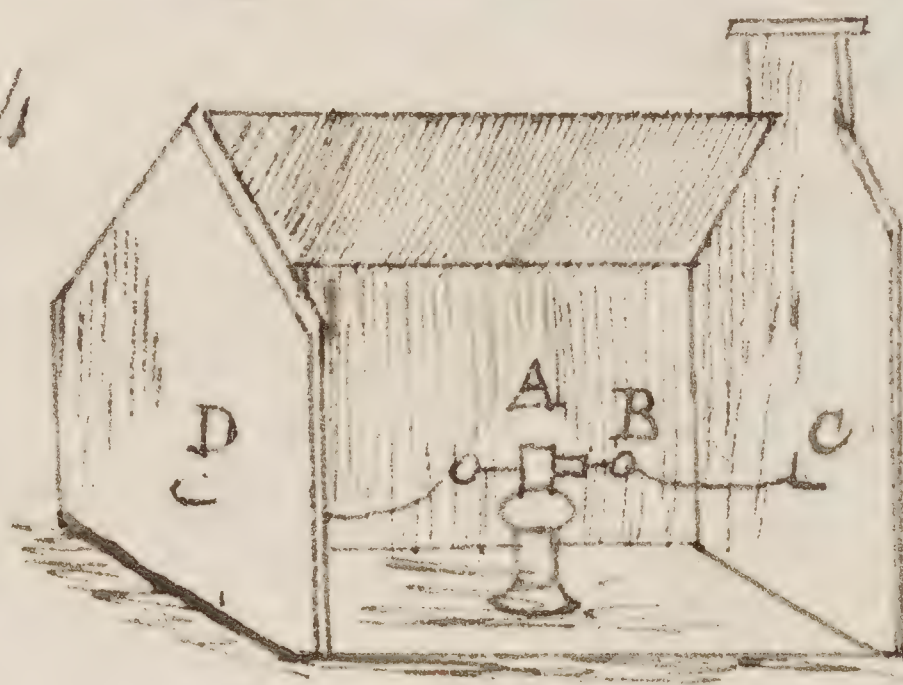
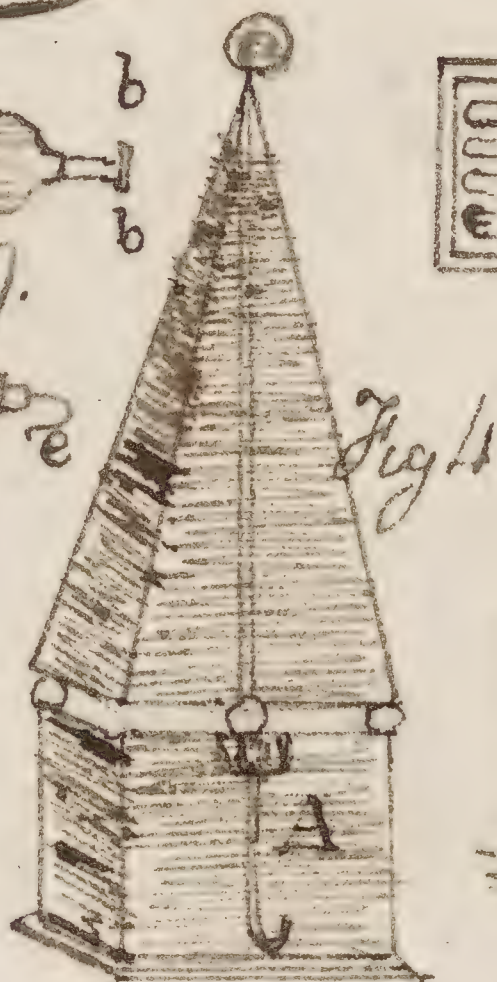
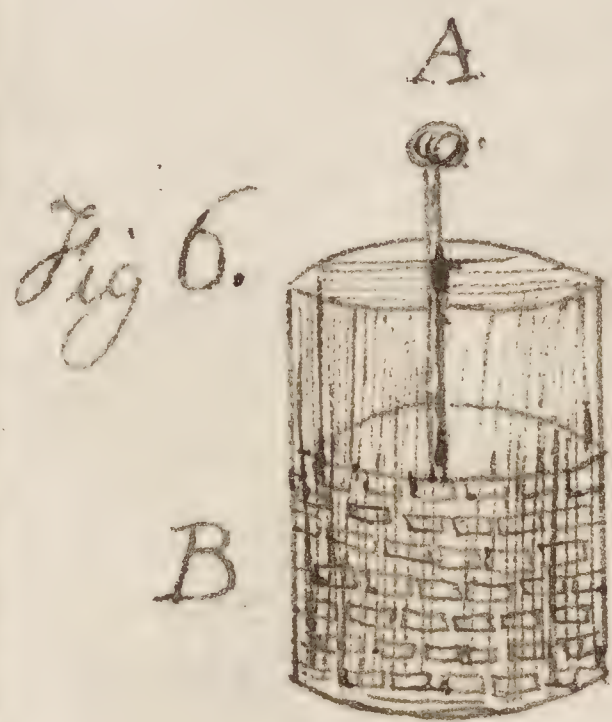
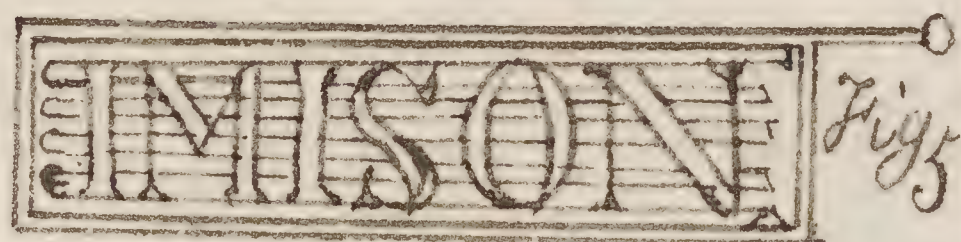
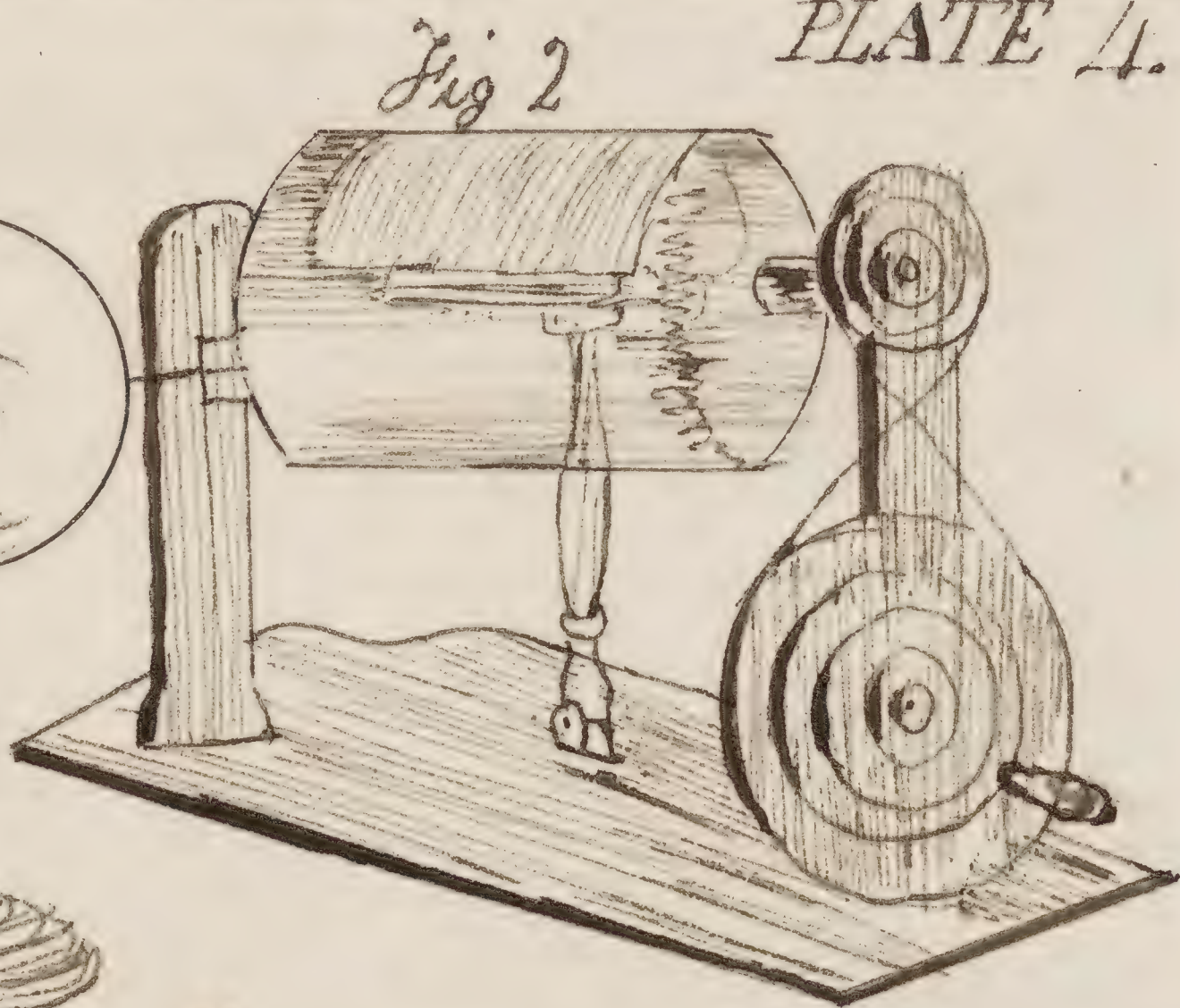
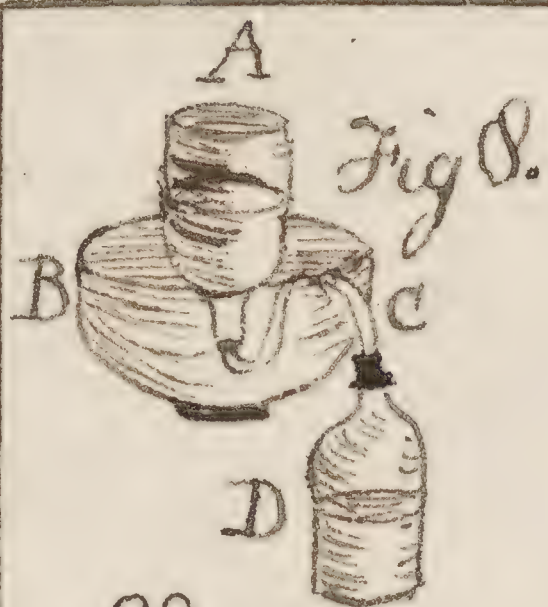
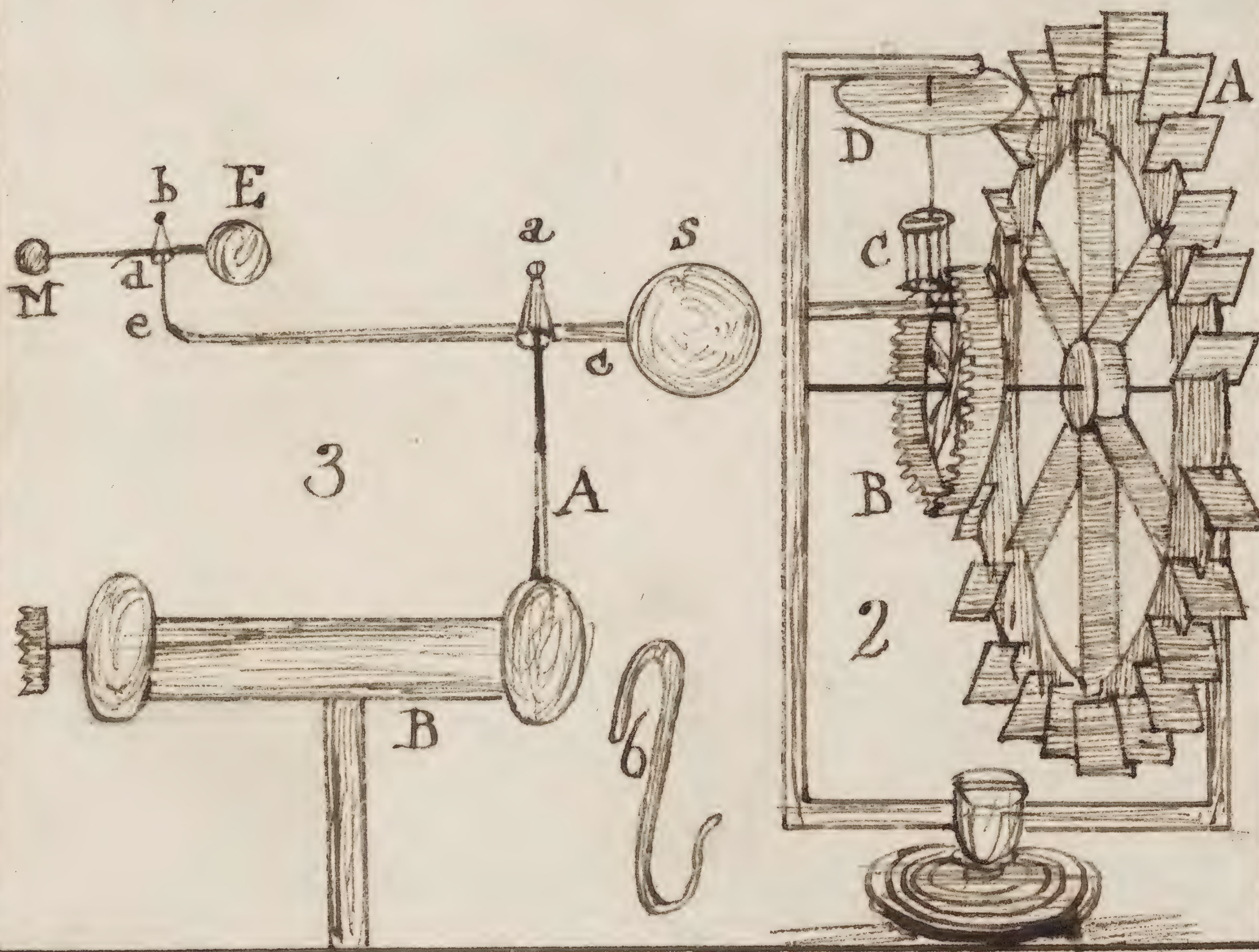
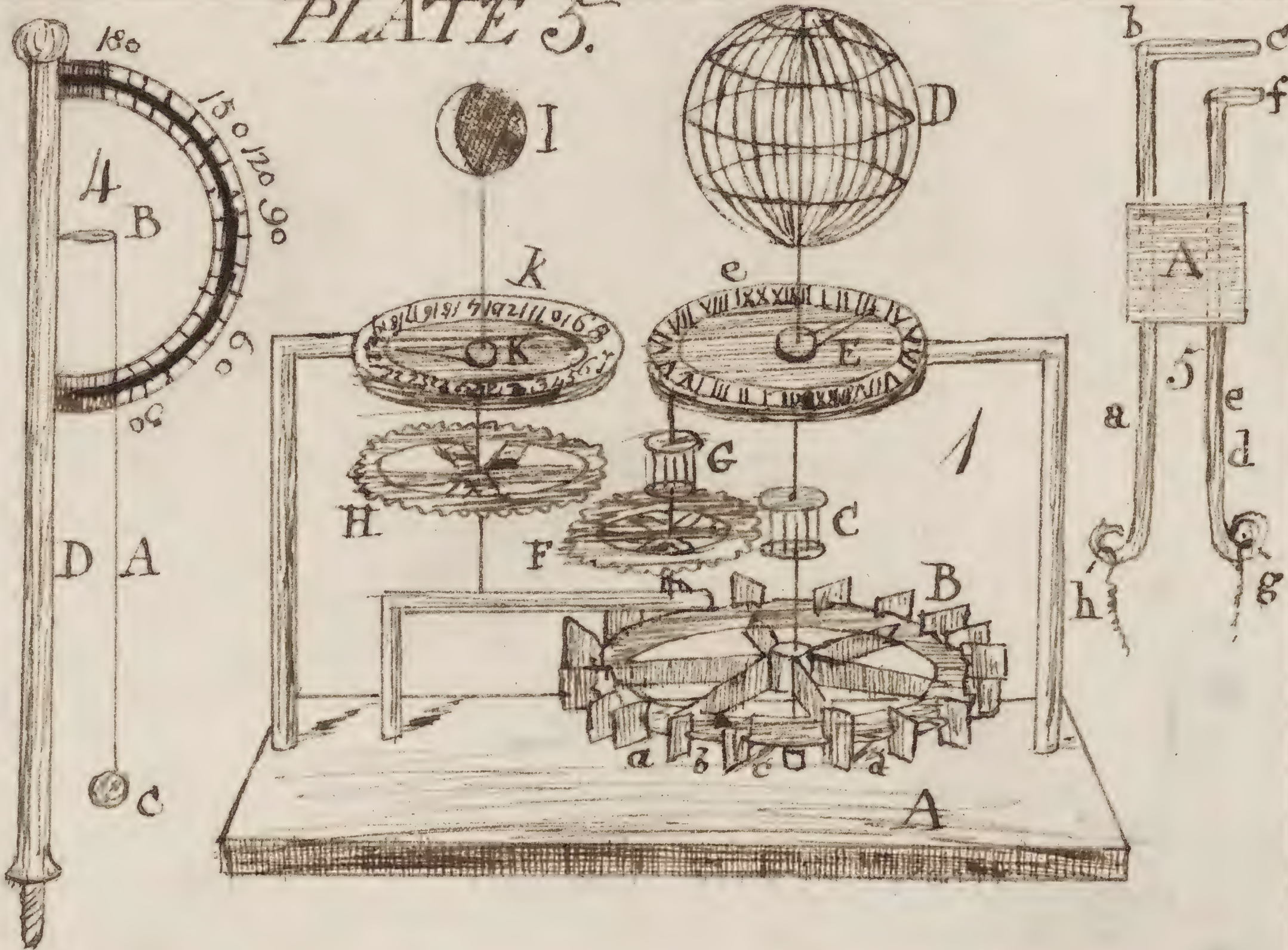


Plate 5

PLATE 5.



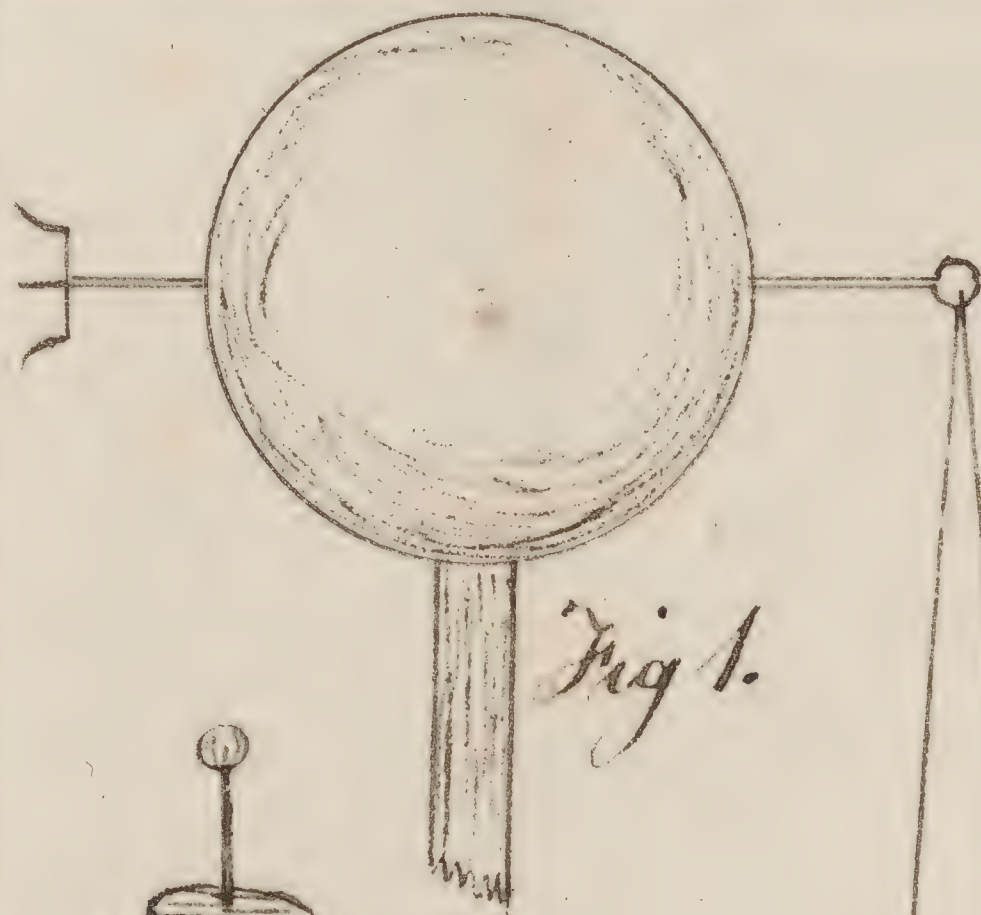
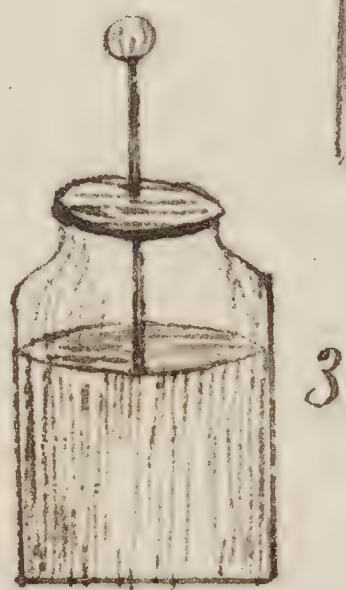


Fig 1.



3

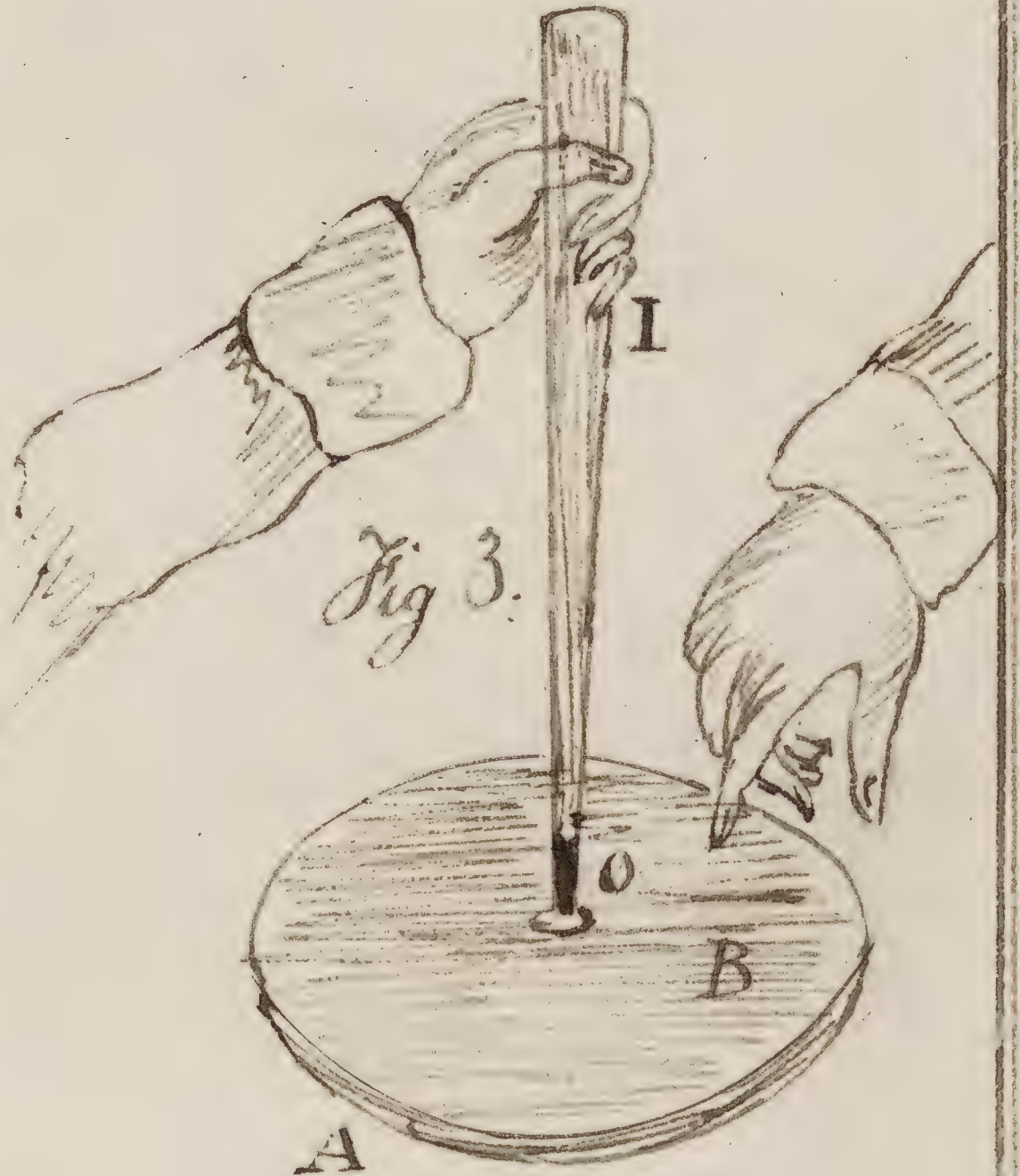


Fig 3.



Fig 2.

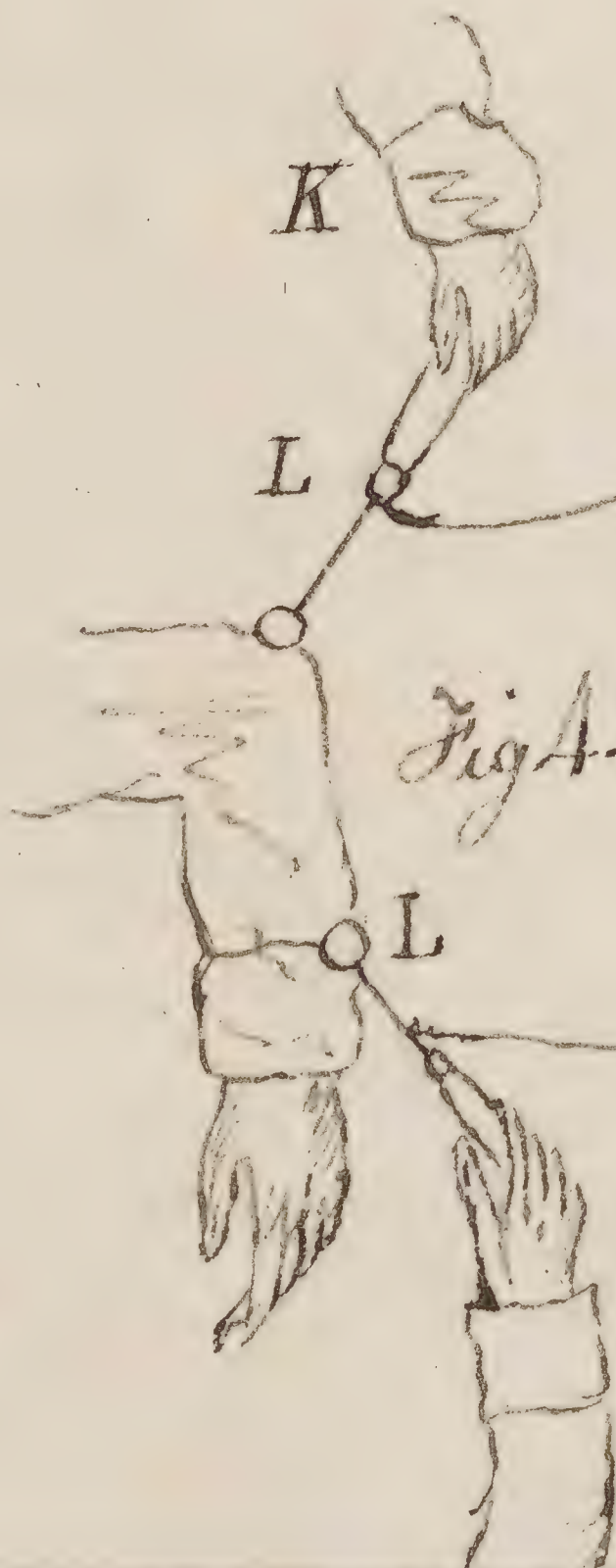


Fig 4.

